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(54) **IMPLANTABLE SHOULDER PROSTHESES**

(75) Inventors: **J. Christopher Flaherty**, Auburndale,
FL (US); **Paul V. Fenton**, Marblehead,
MA (US); **Amory Adrian Gregory**
Martin, Paris (FR)

(73) Assignee: **Topsfield Medical GMBH** (DE)

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A61F 2/40 (2006.01)
A61F 2/46 (2006.01)

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CPC **A61F 2/40** (2013.01); **A61F 2/30749**
(2013.01); **A61F 2/4014** (2013.01); **A61F**
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(58) **Field of Classification Search**

CPC . A61F 2/40; A61F 2/4081; A61F 2002/4085;
A61F 2/30723; A61F 2002/3433; A61B
17/7098; A61M 2039/027
USPC 623/19.11–19.13; 606/300
See application file for complete search history.

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Primary Examiner — Bruce E Snow

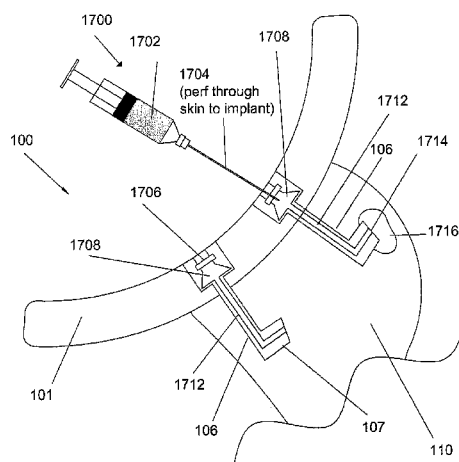
Assistant Examiner — Brian Dukert

(74) *Attorney, Agent, or Firm* — Onello & Mello, LLP

(57) **ABSTRACT**

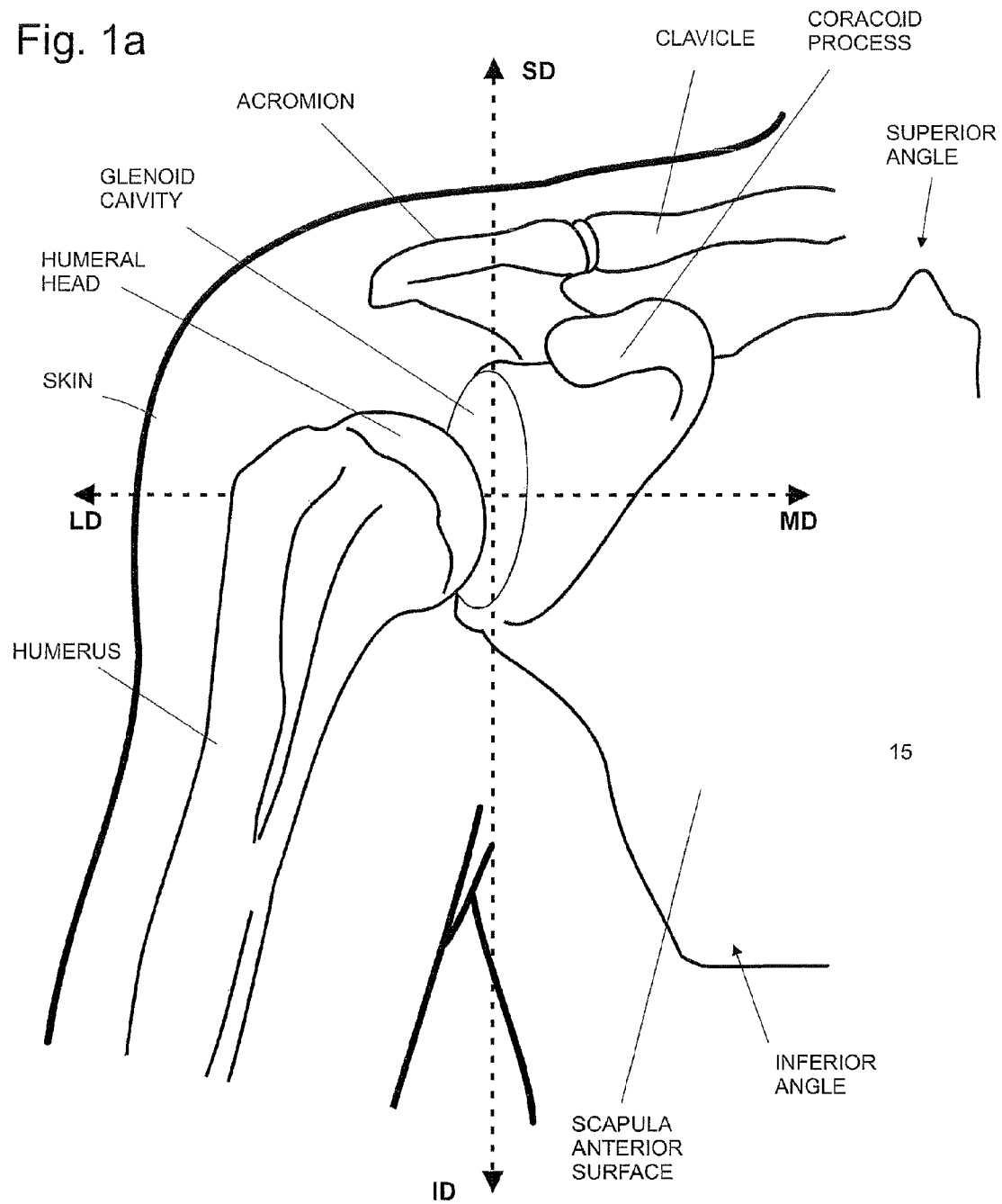
Prosthesis, tools and surgical methods treat joint instability
by avoiding loosening over time. A shoulder prosthesis
includes a humeral member with a humeral joint surface and
a humeral fixation member and a glenoid member comprising
a glenoid body with a glenoid joint surface, and a glenoid
fixation member attaching the glenoid body to a scapula. The
glenoid fixation member may be attached orthogonally to the
scapula. A dampener may be included to absorb loads that
may loosen one or more components of the prosthesis.

8 Claims, 30 Drawing Sheets



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- (52) **U.S. Cl.**
 CPC *A61F2/30742* (2013.01); *A61F 2/30942*
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2002/30565 (2013.01); *A61F 2002/30578*
 (2013.01); *A61F 2002/30579* (2013.01); *A61F*
2002/30635 (2013.01); *A61F 2002/30672*
 (2013.01); *A61F 2002/30736* (2013.01); *A61F*
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 (2013.01); *A61F 2002/4022* (2013.01); *A61F*
2002/4085 (2013.01); *A61F 2002/4631*
 (2013.01); *A61F 2002/4666* (2013.01); *A61F*
2002/484 (2013.01); *A61F 2310/00359*
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Fig. 1a



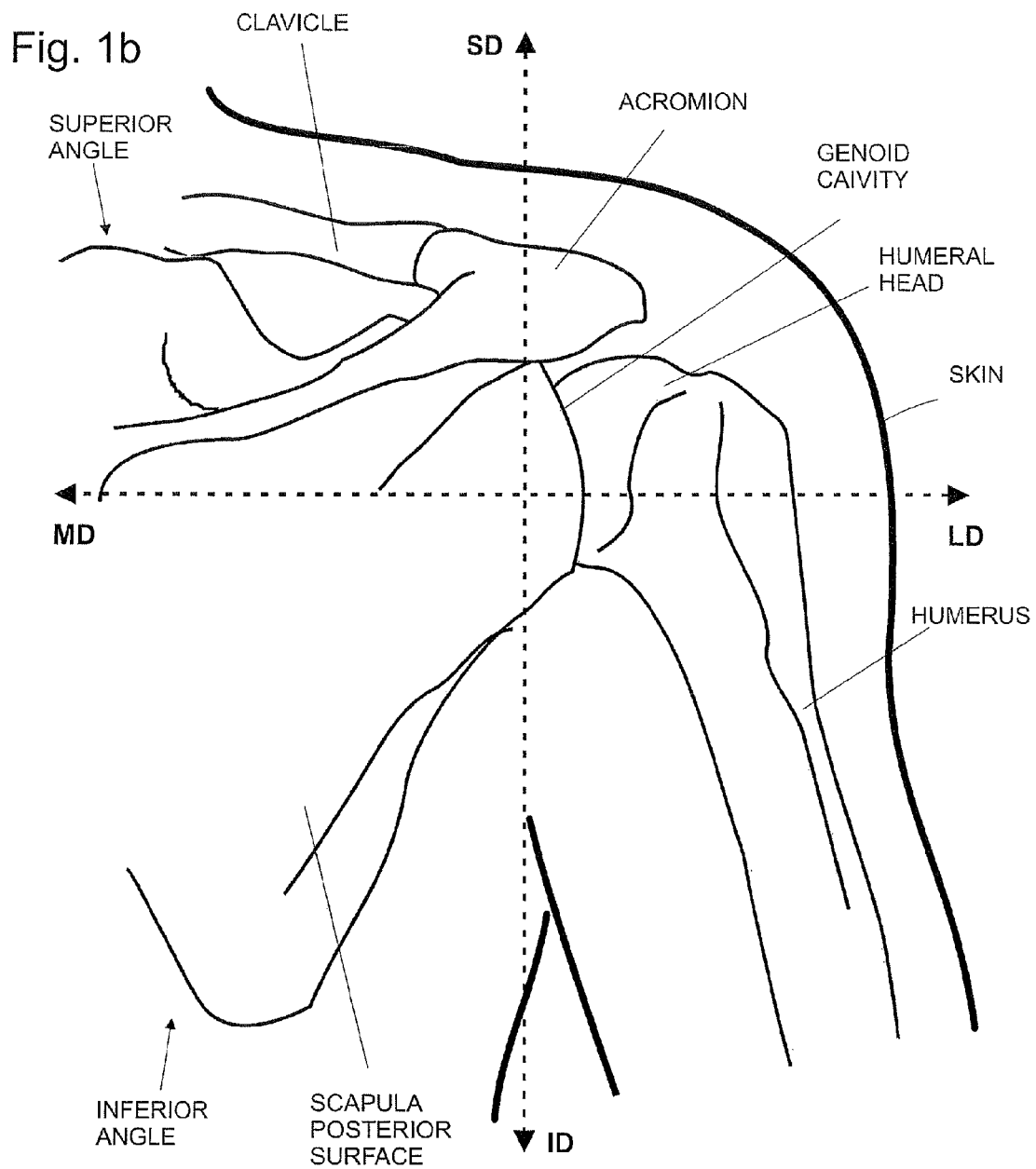


Fig. 1c

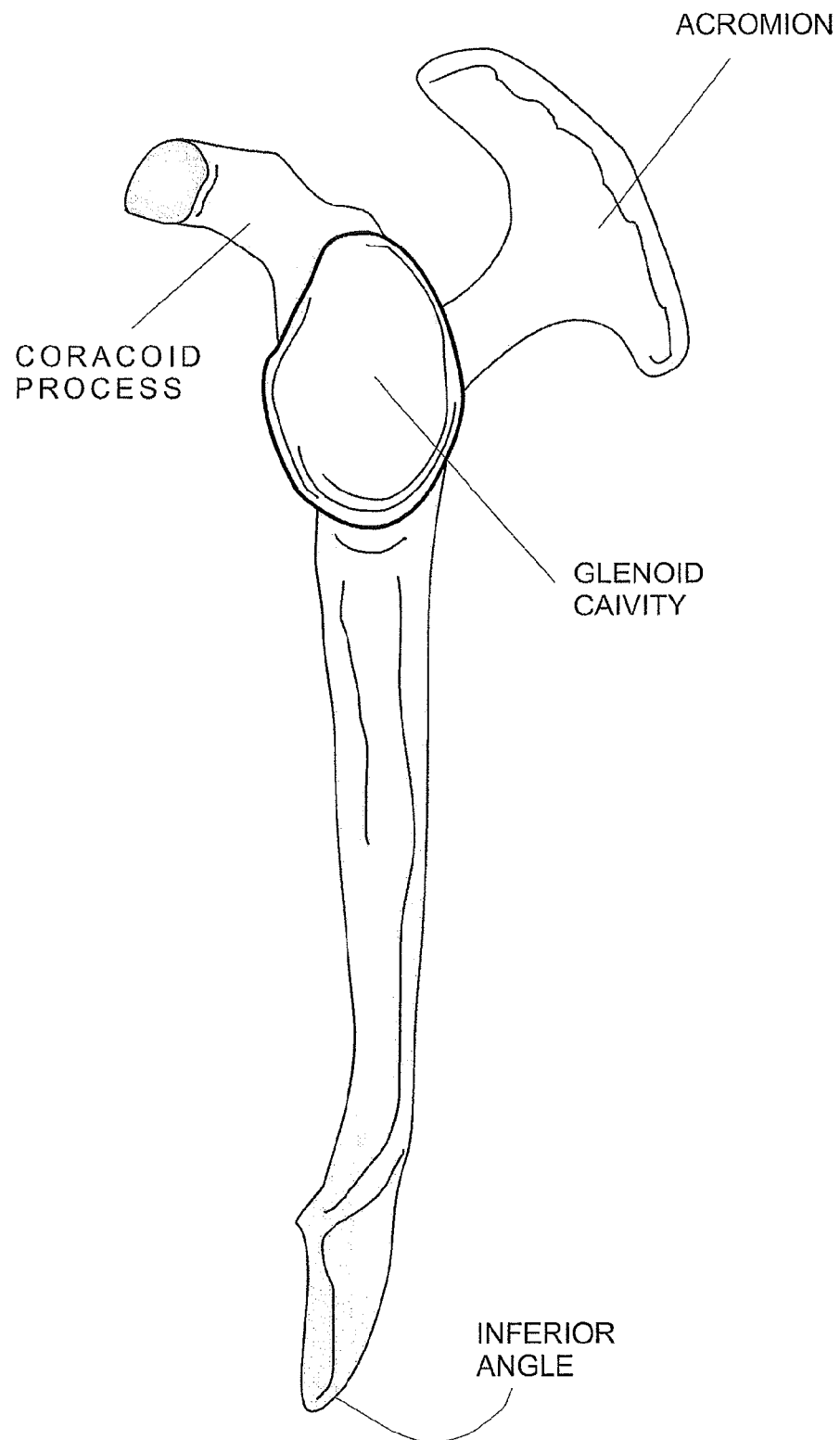


Fig. 3a

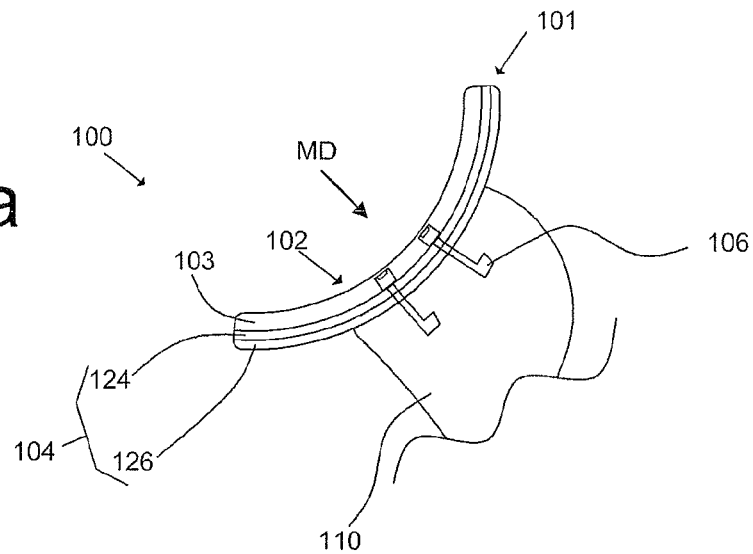


Fig. 3b

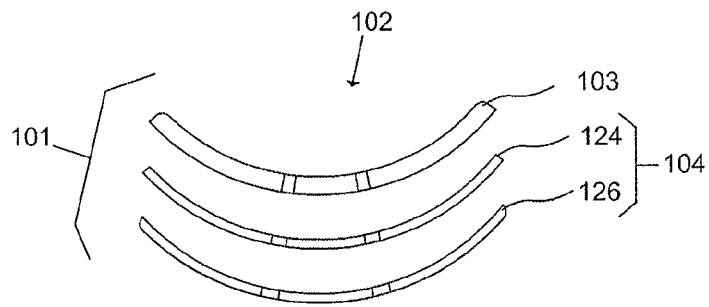


Fig. 3c

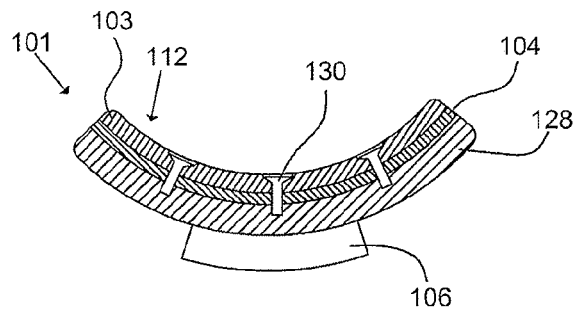


Fig. 4

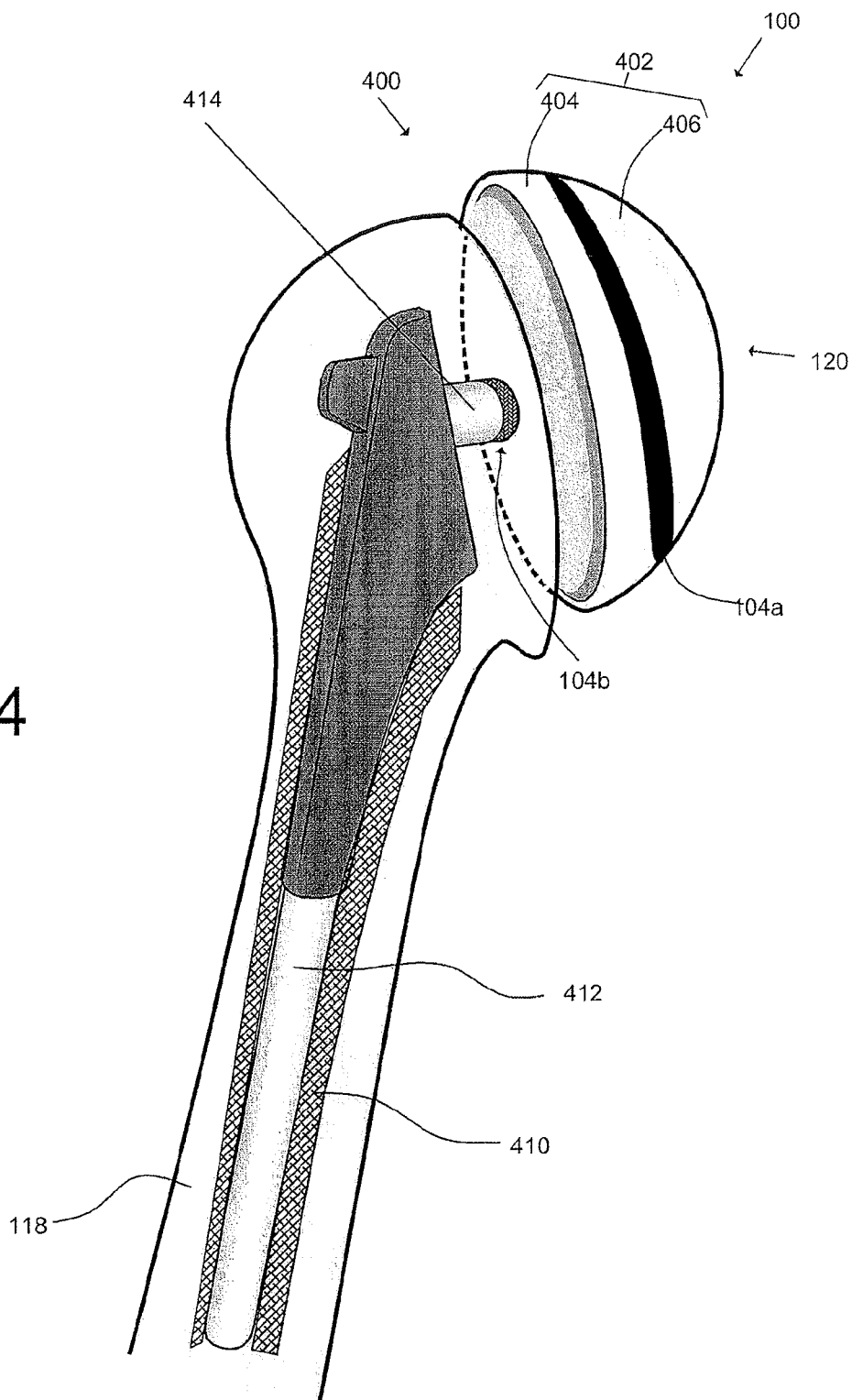
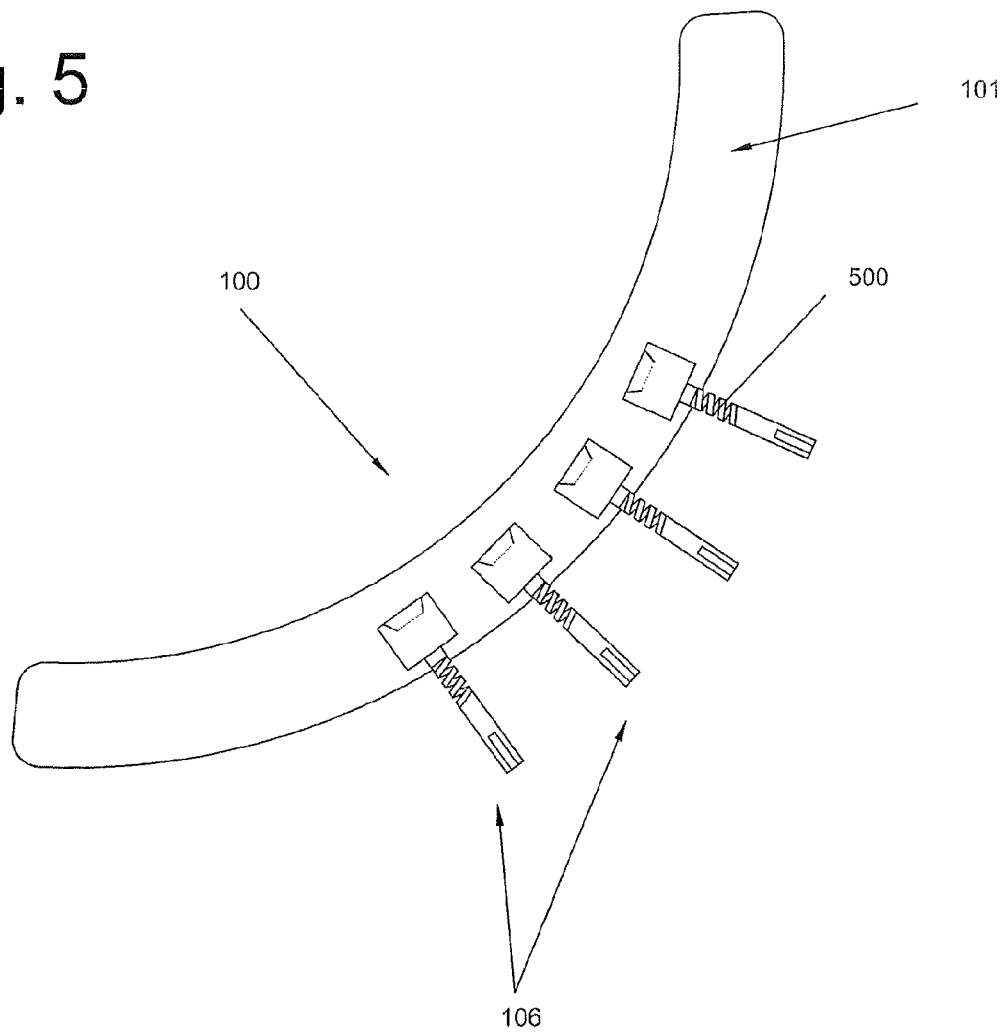
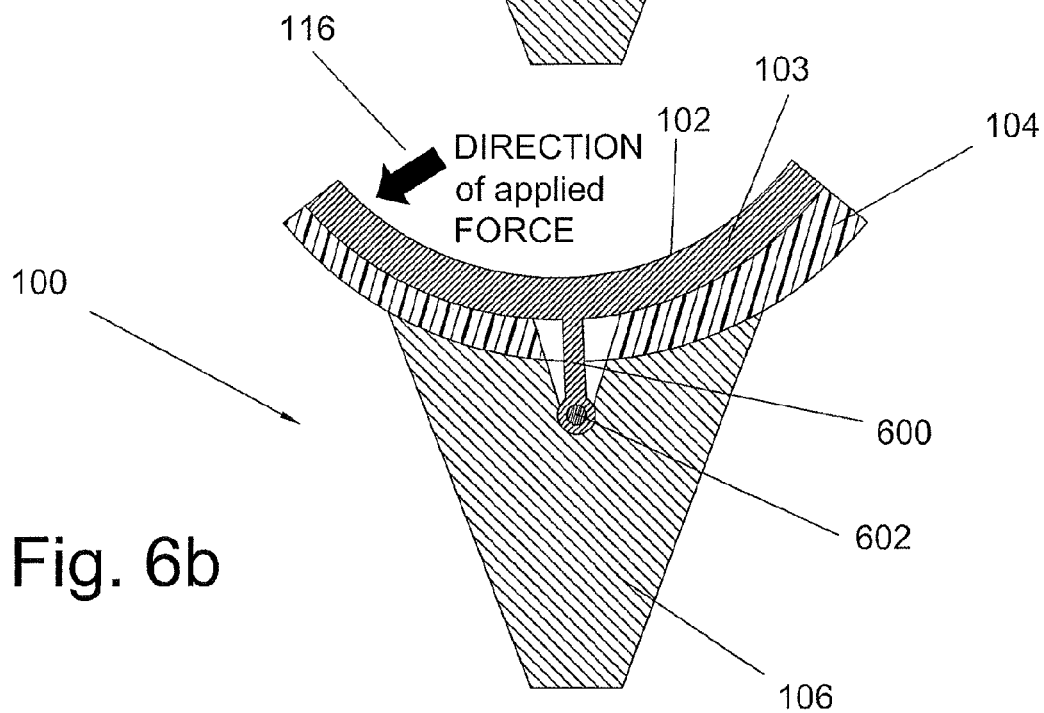
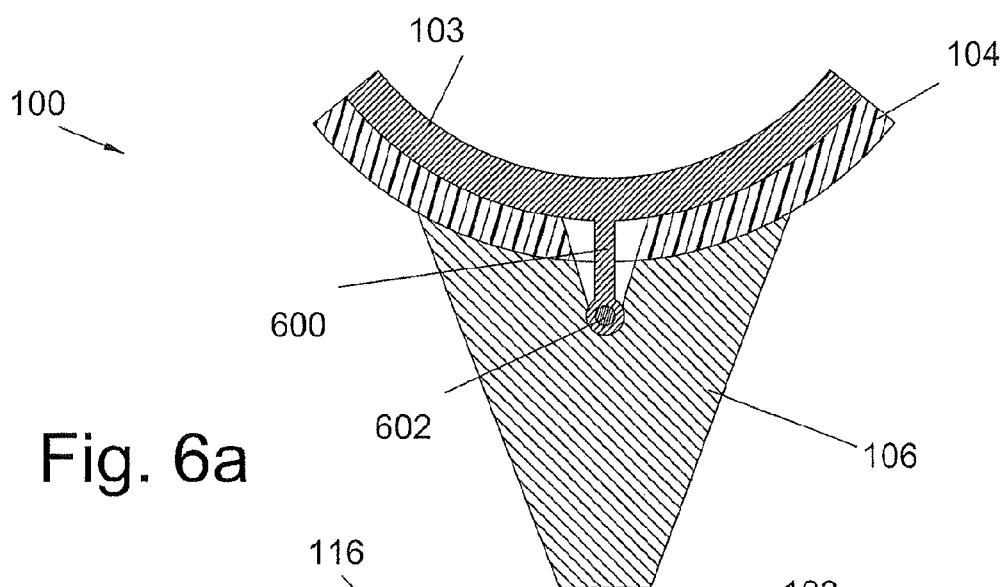


Fig. 5





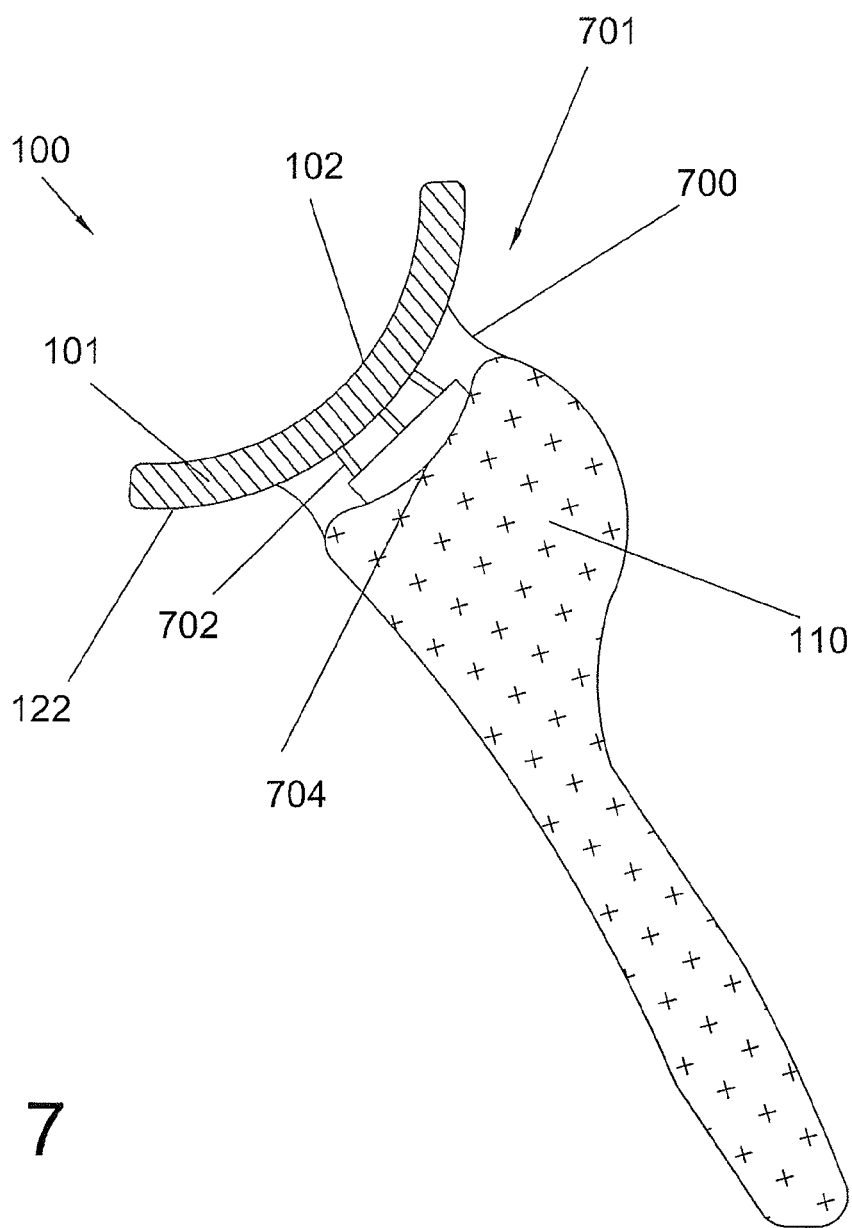
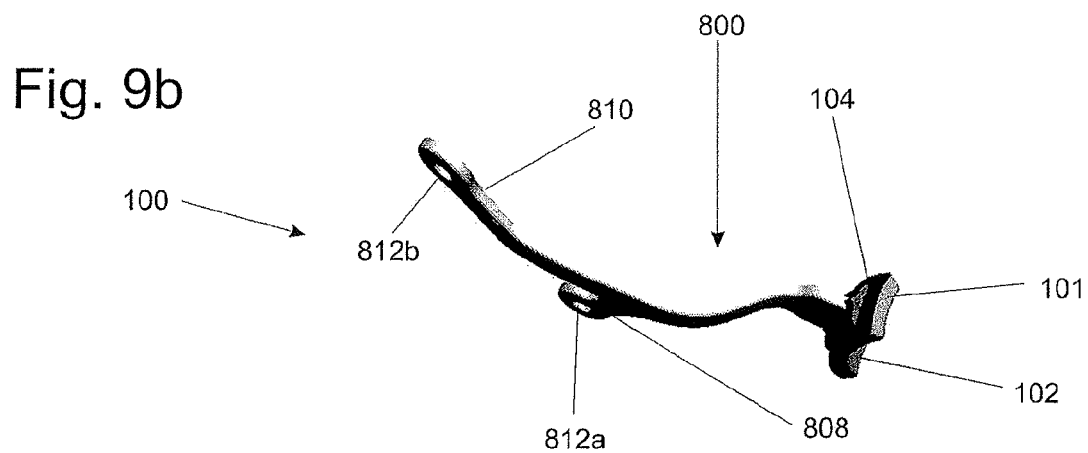
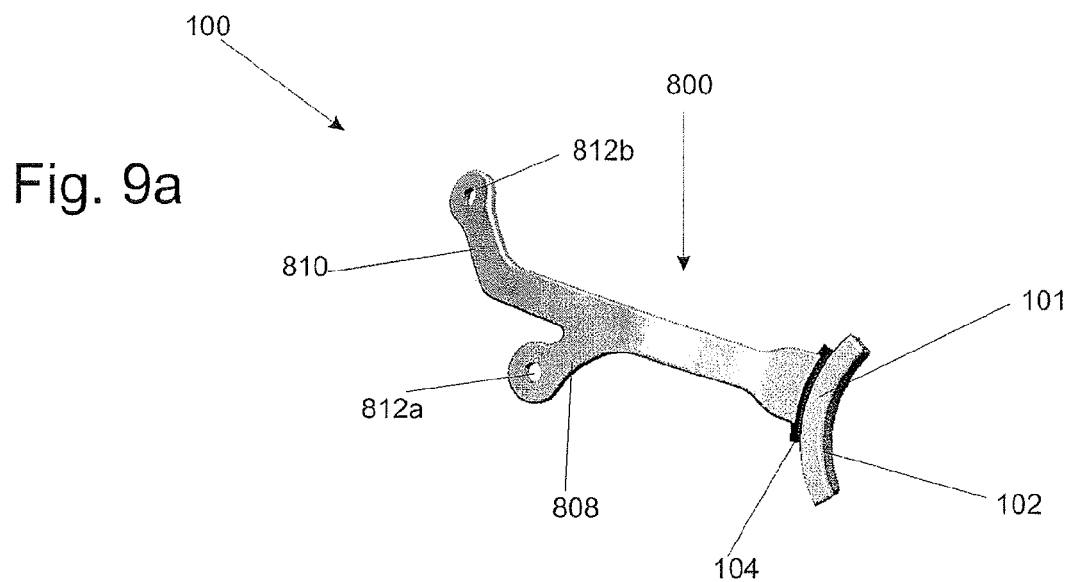
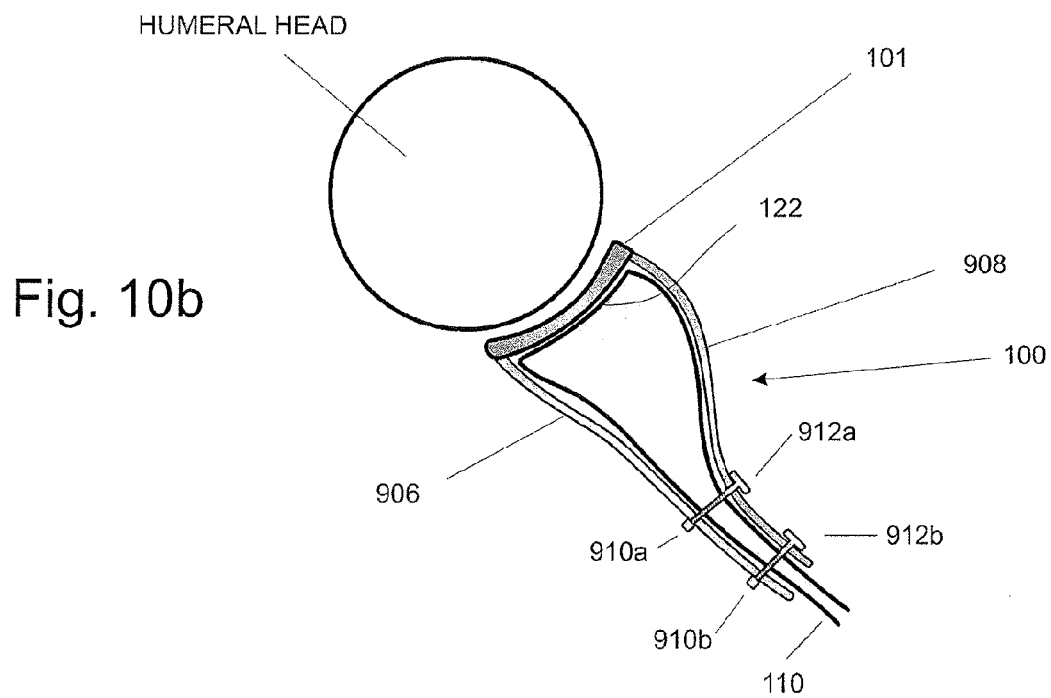
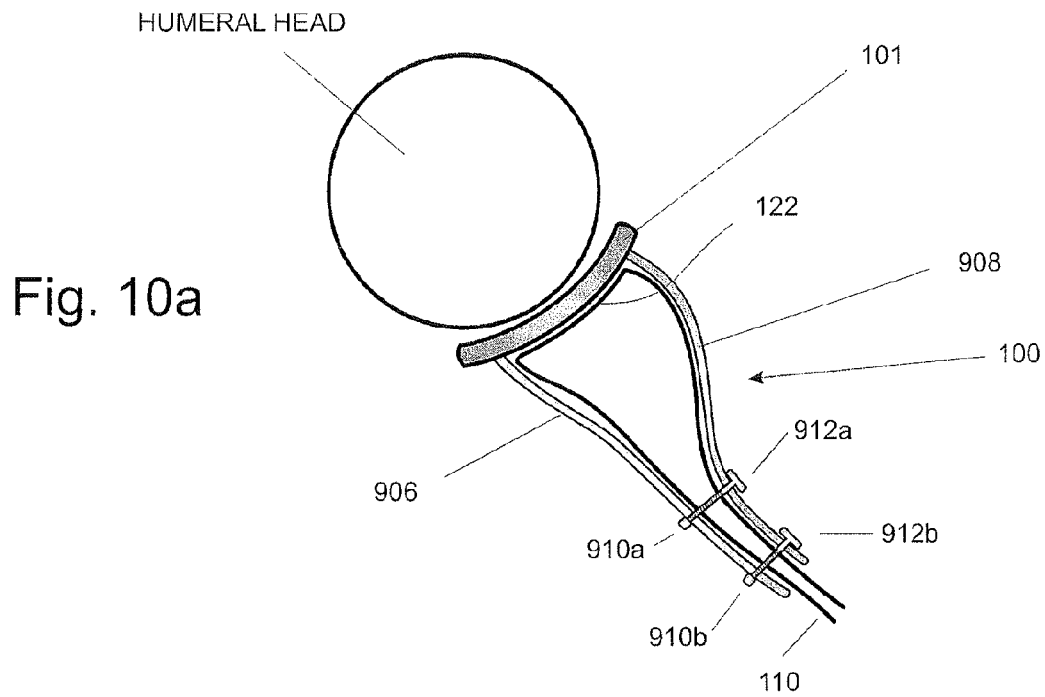


Fig. 7





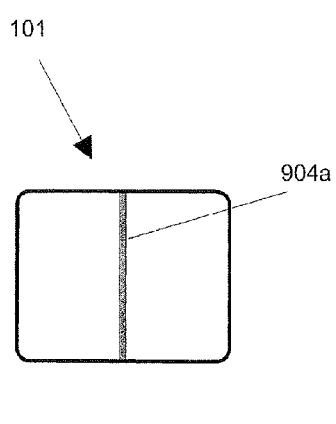
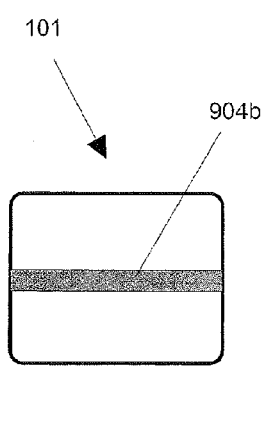
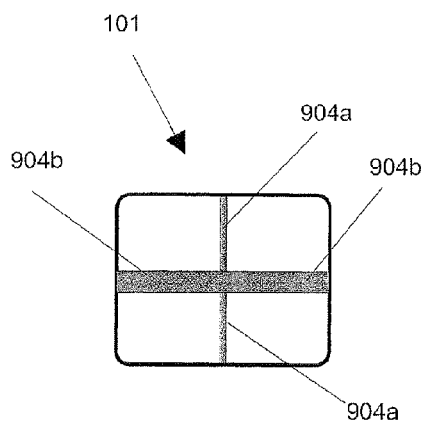
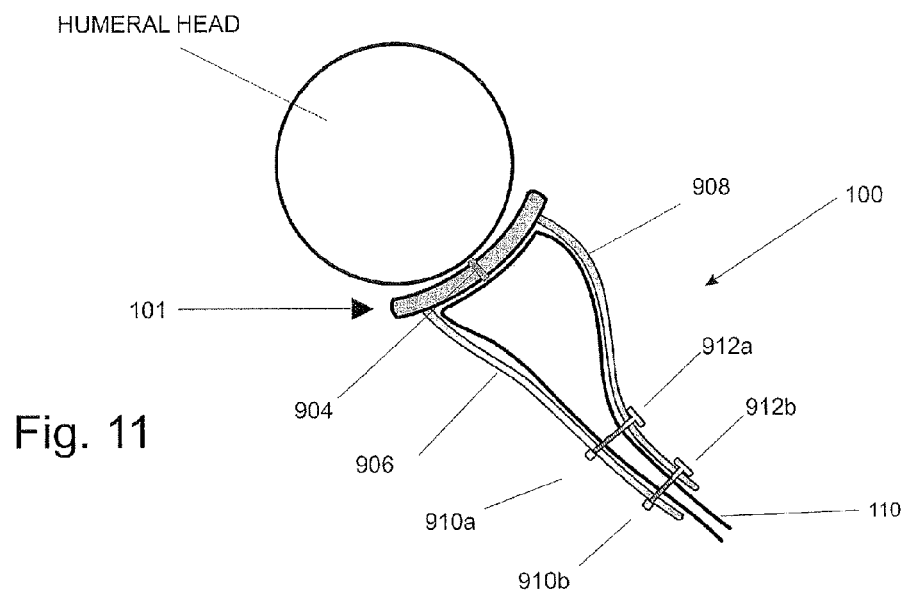


Fig. 13a

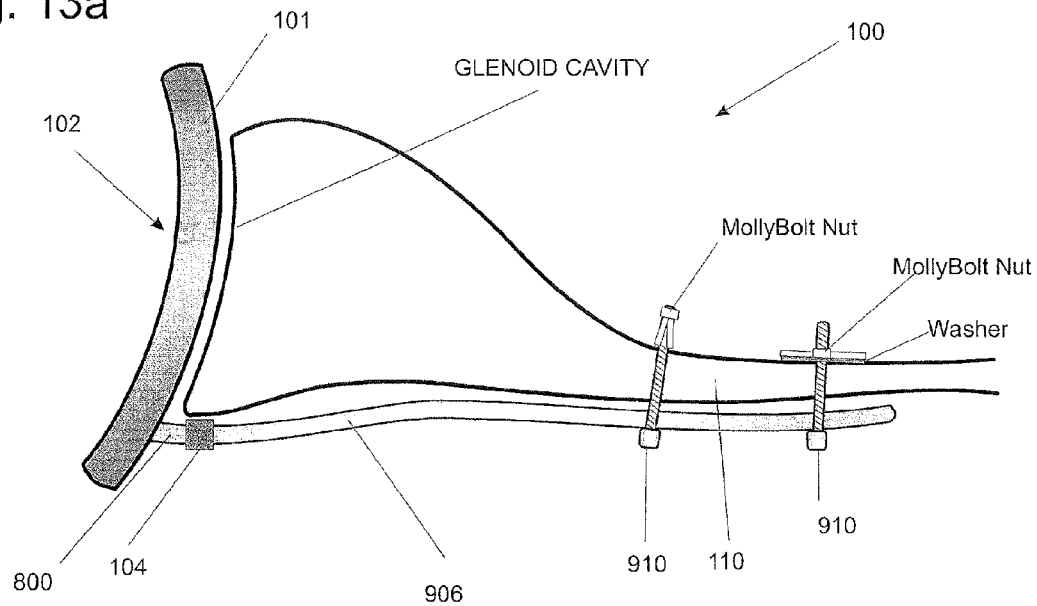


Fig. 13b

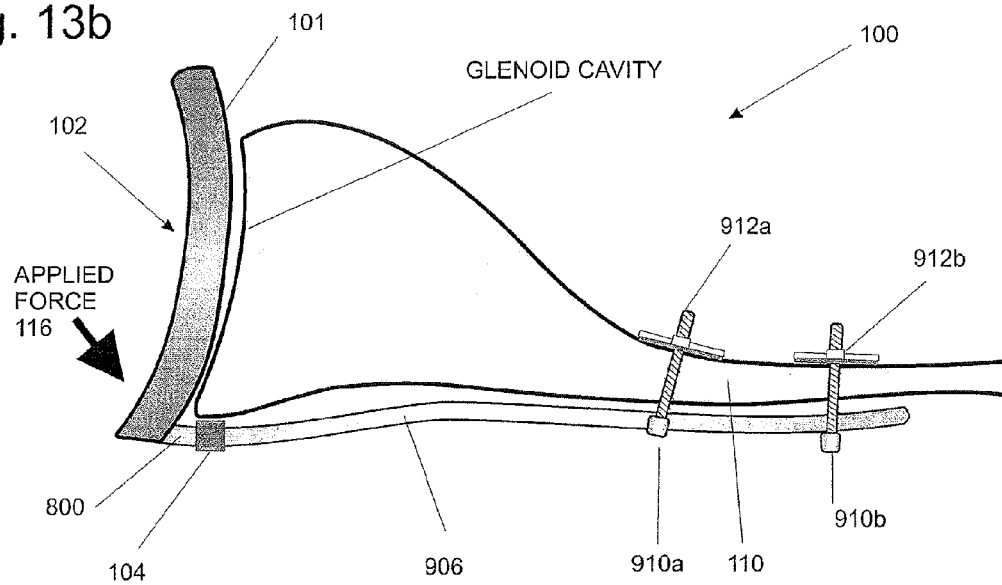


Fig. 14

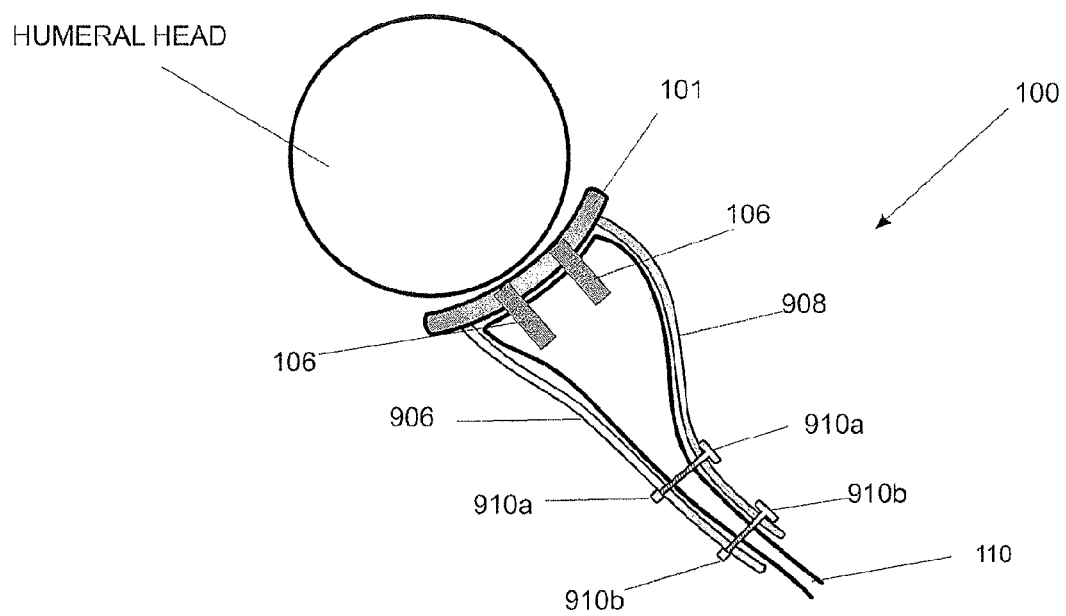


Fig. 15

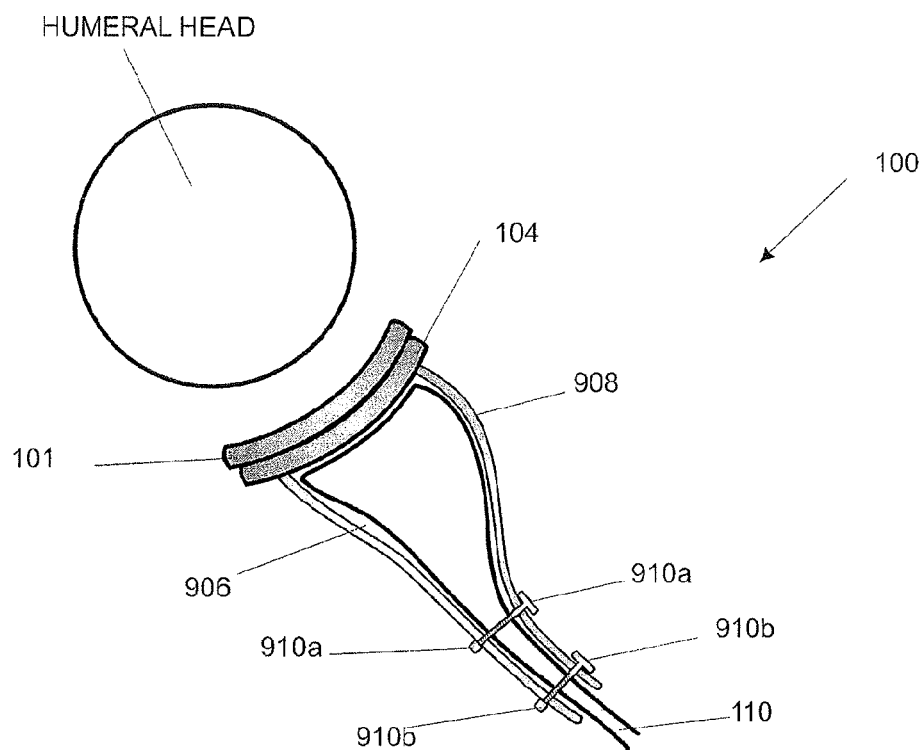


Fig. 16

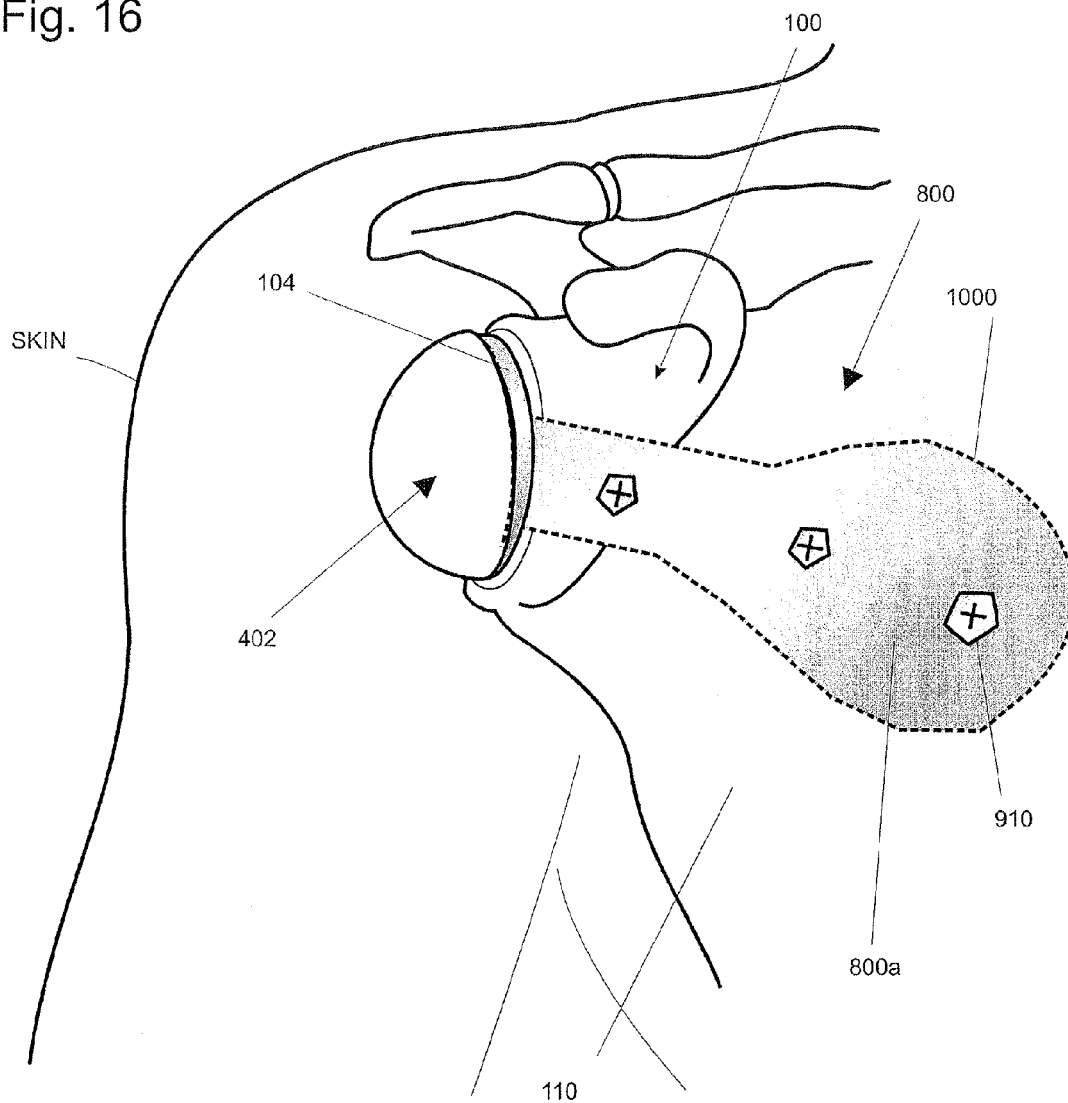


Fig. 17

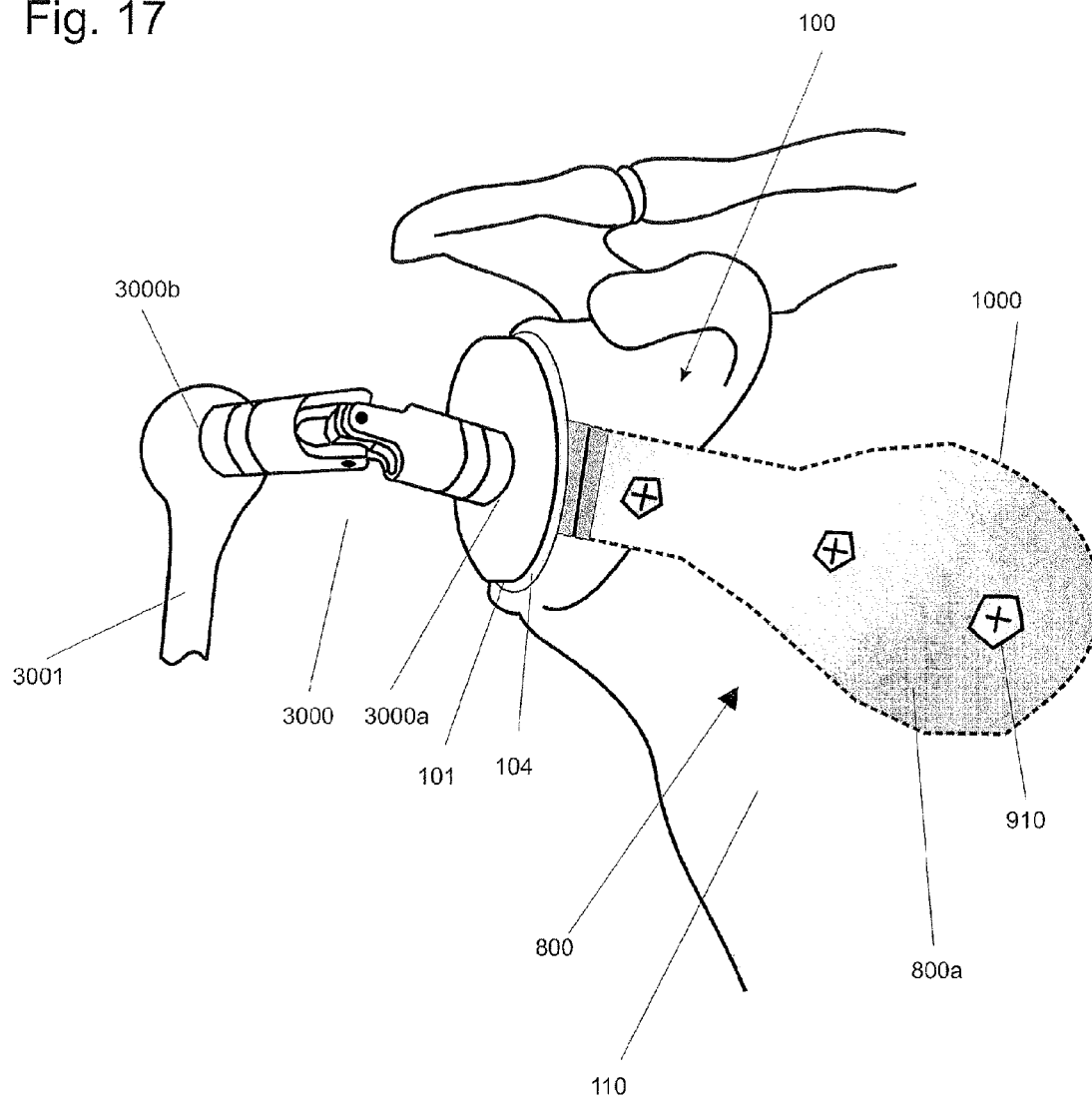
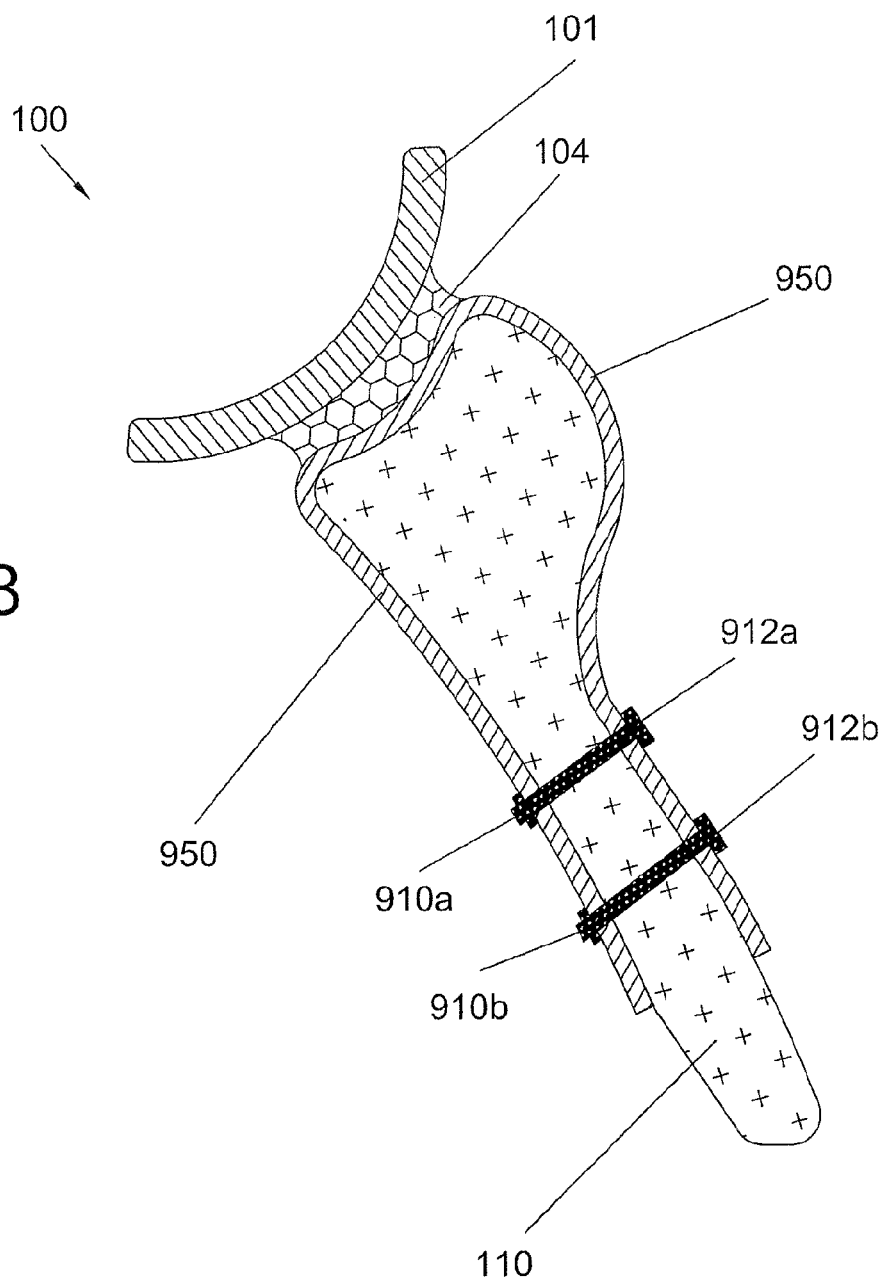


Fig. 18



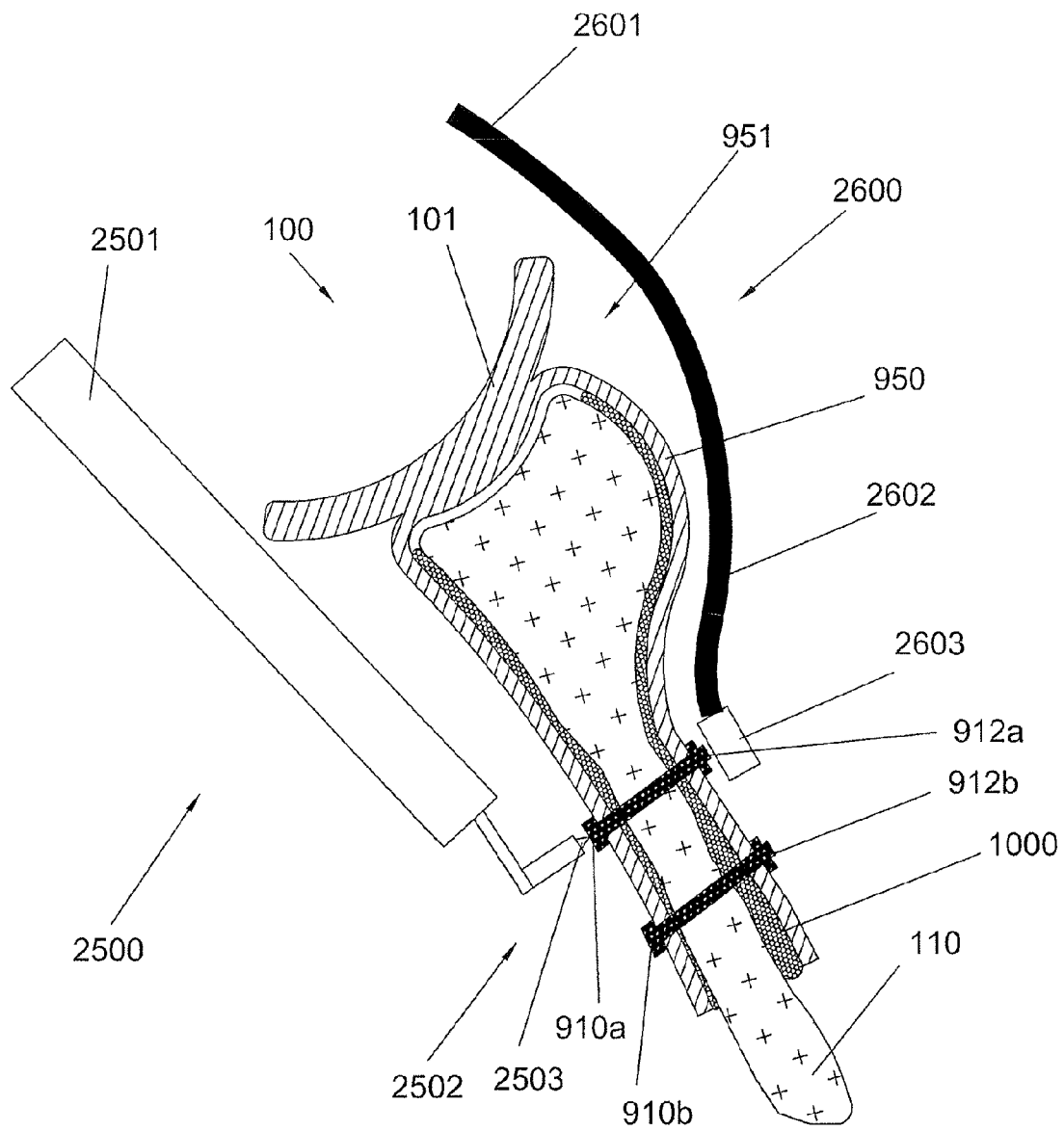
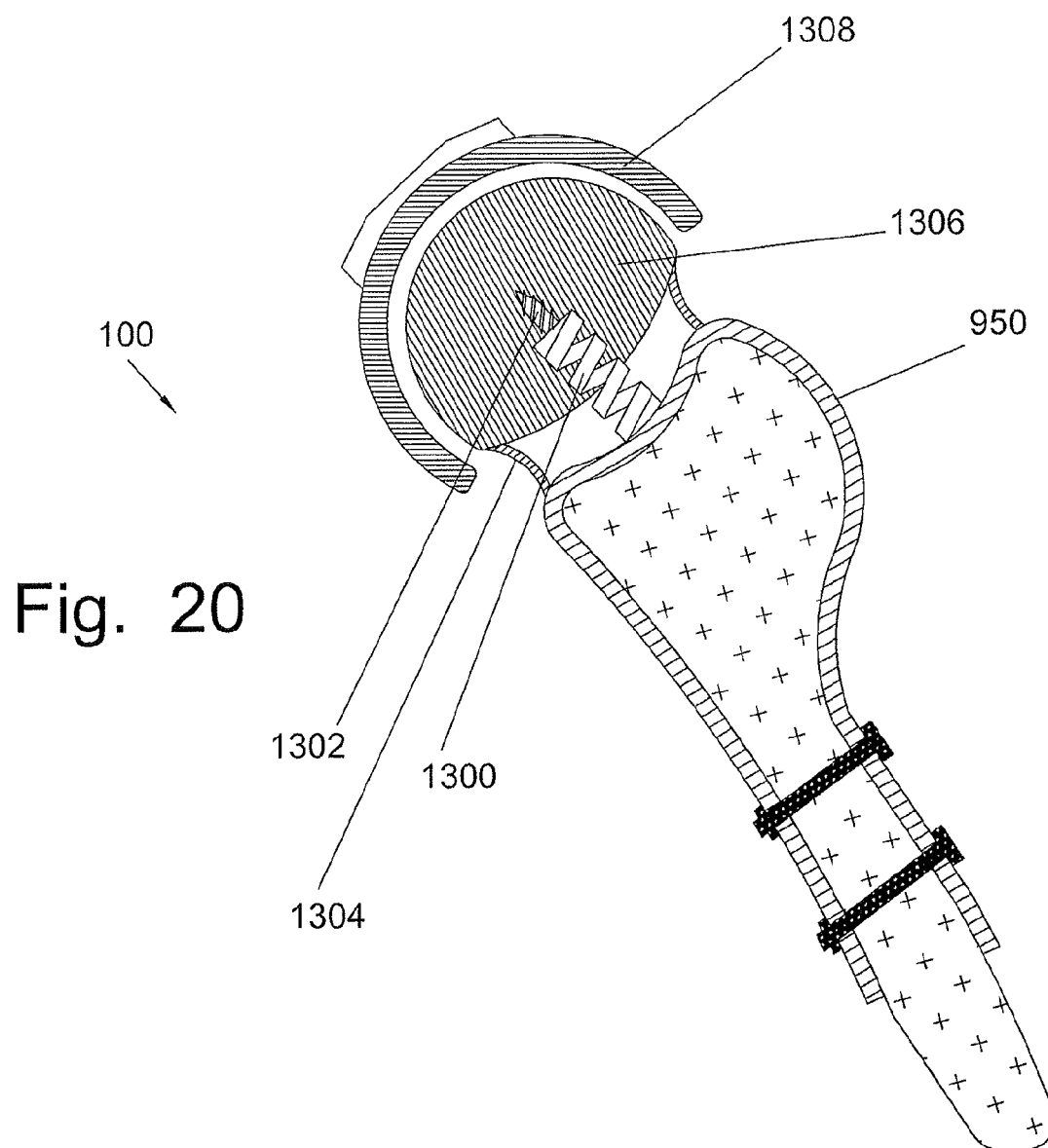


Fig. 19



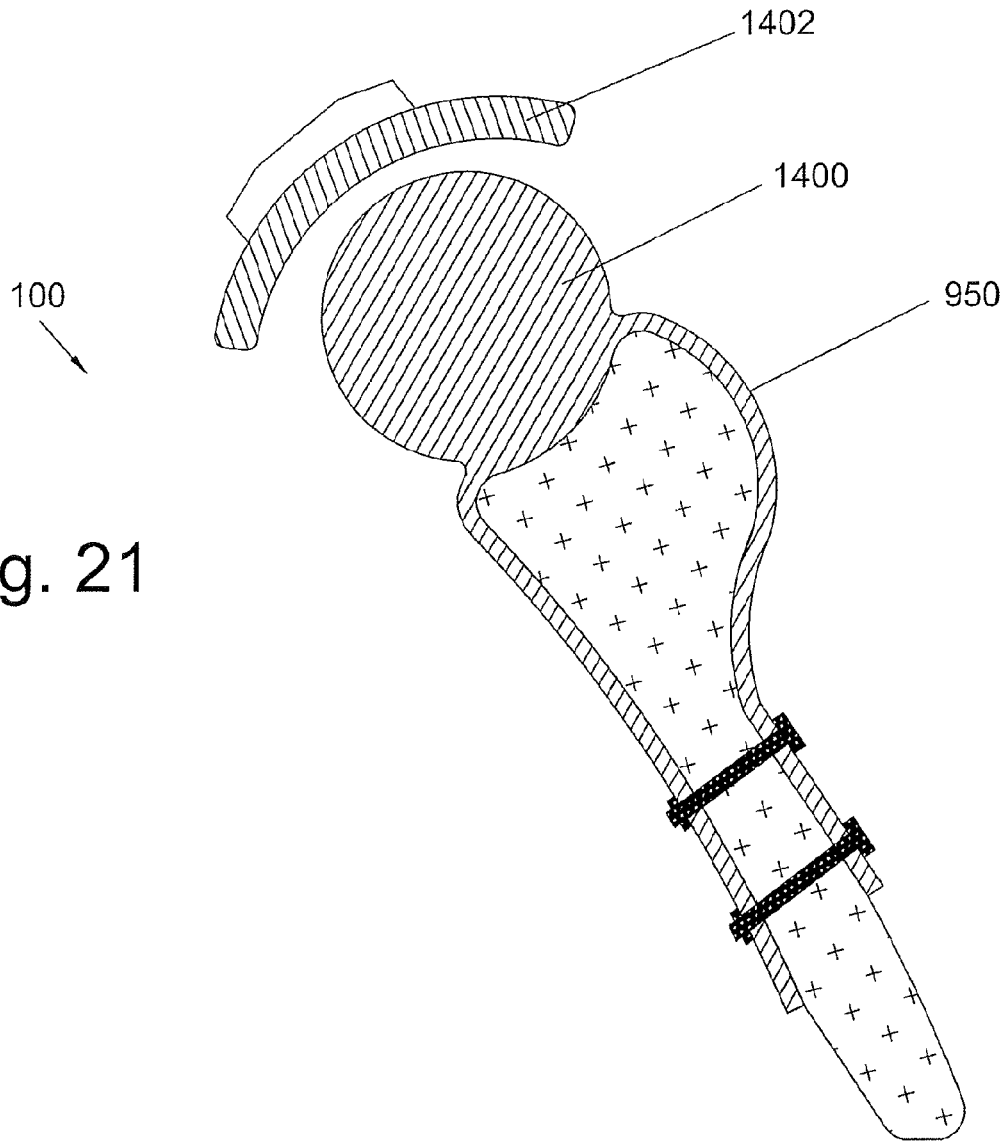


Fig. 21

Fig. 22a

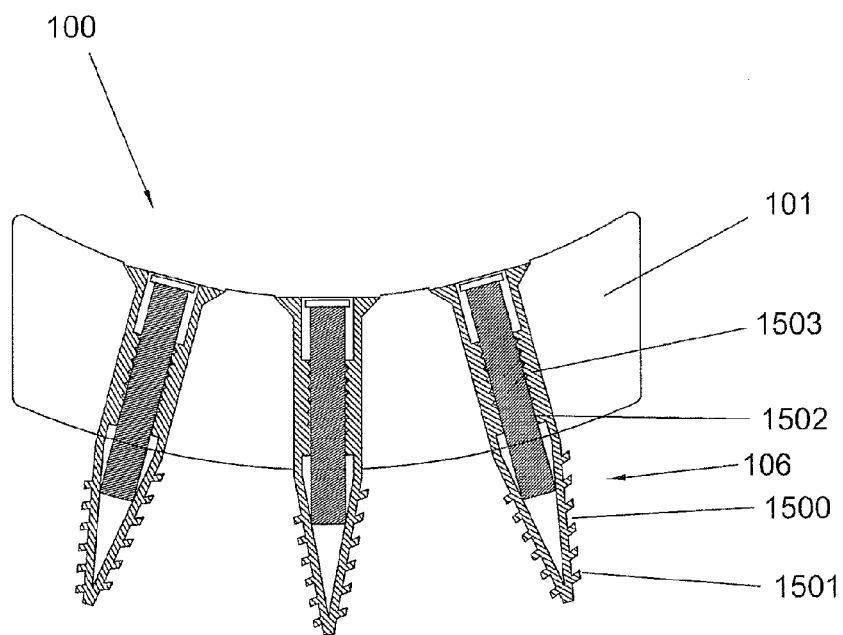


Fig. 22b

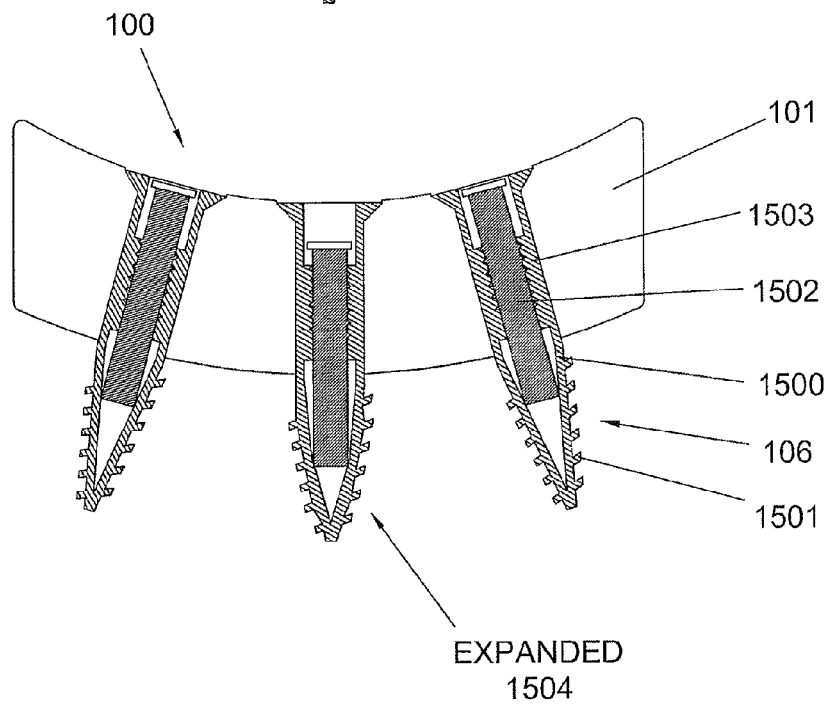


Fig. 23a

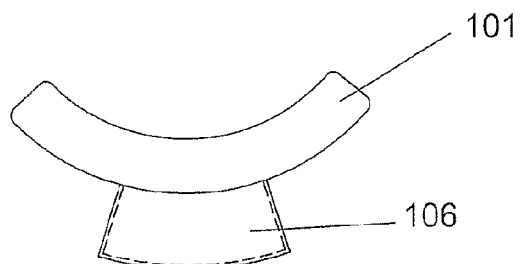


Fig. 23b

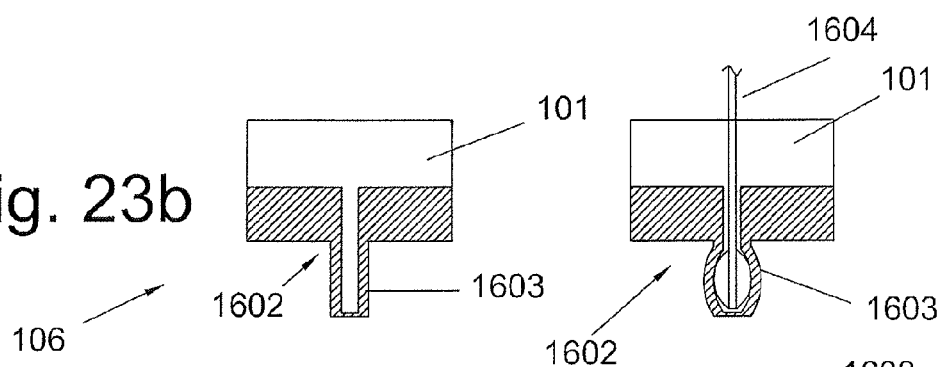


Fig. 23c

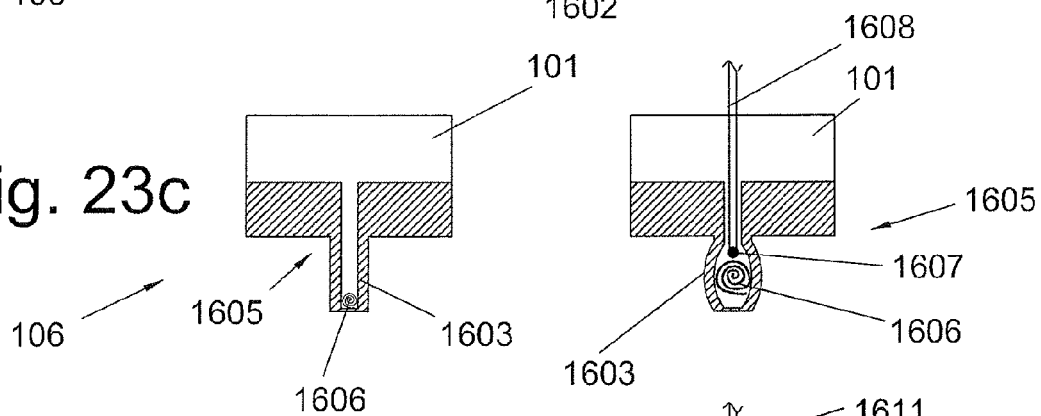
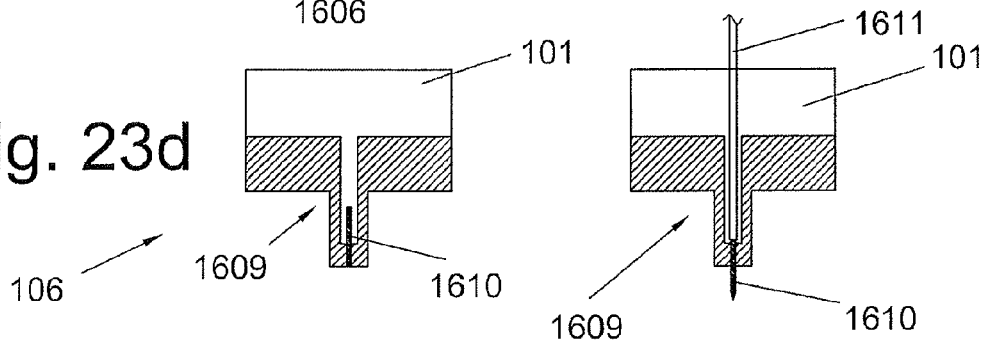


Fig. 23d



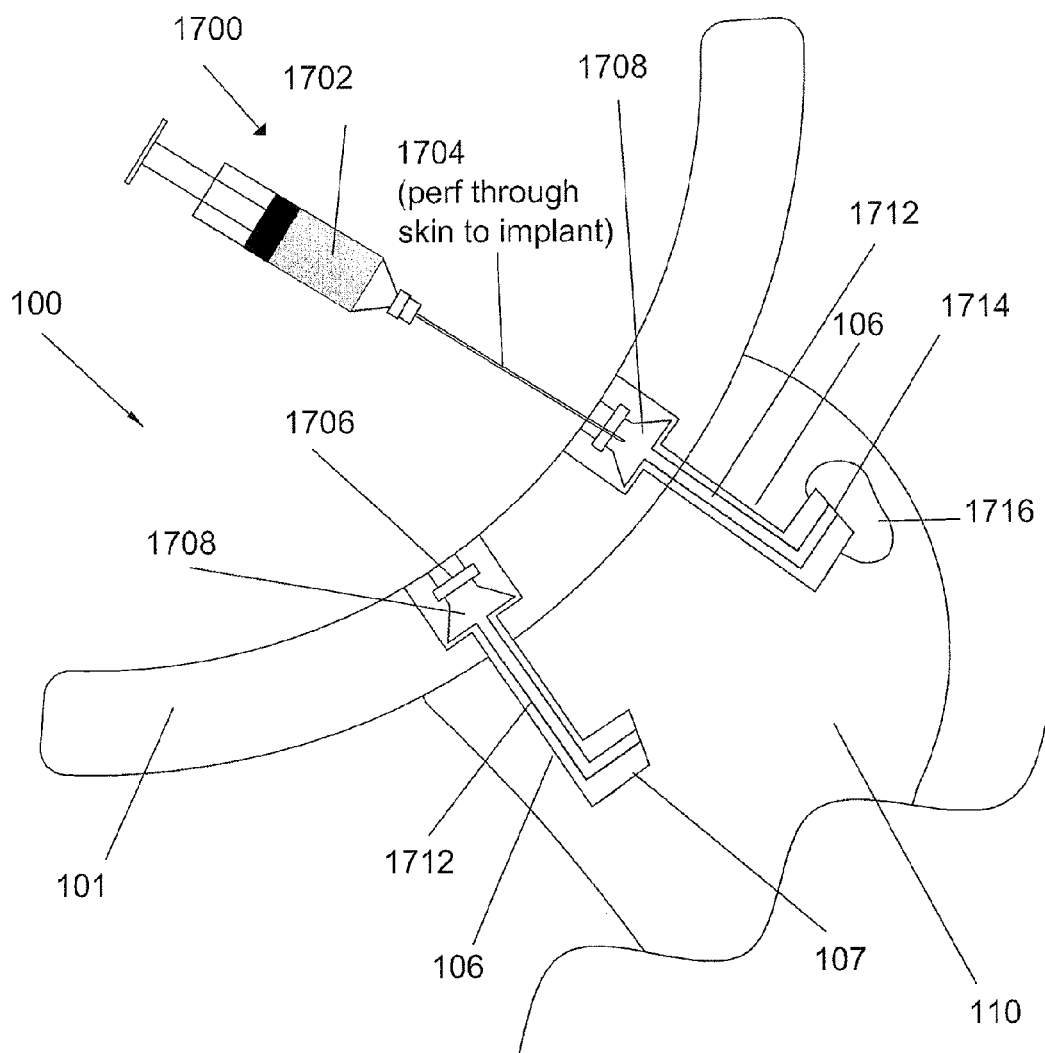


Fig. 24

Fig. 25a

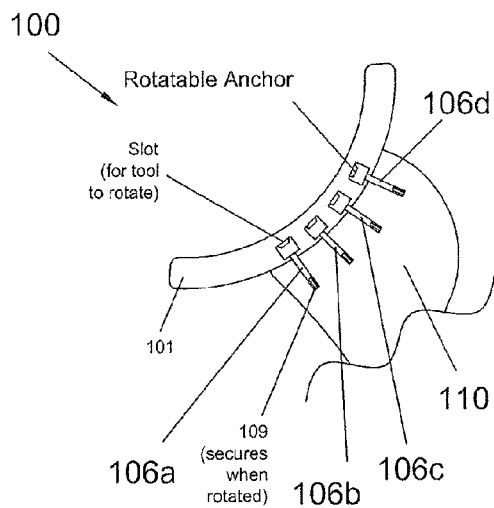


Fig. 25b

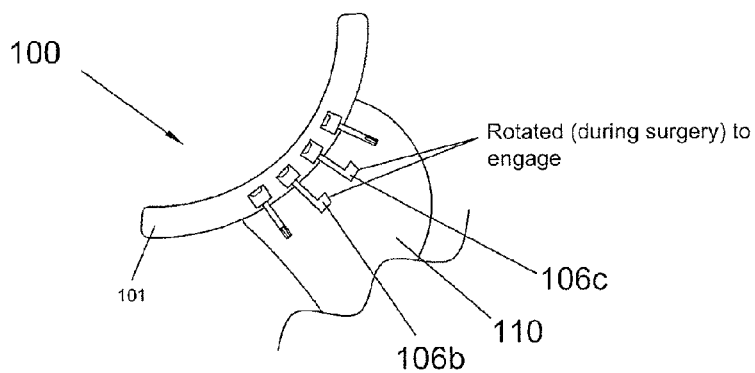
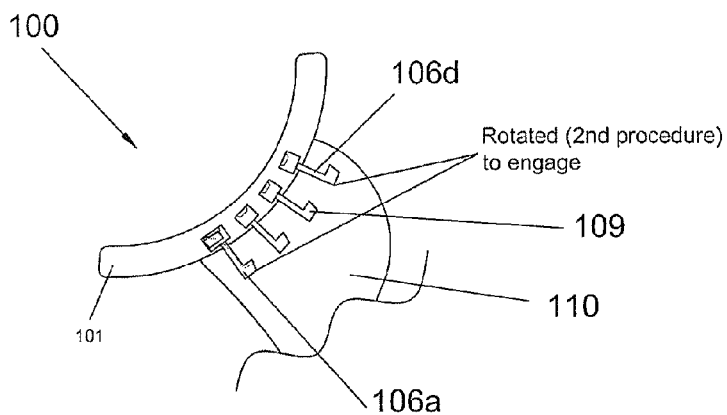


Fig. 25c



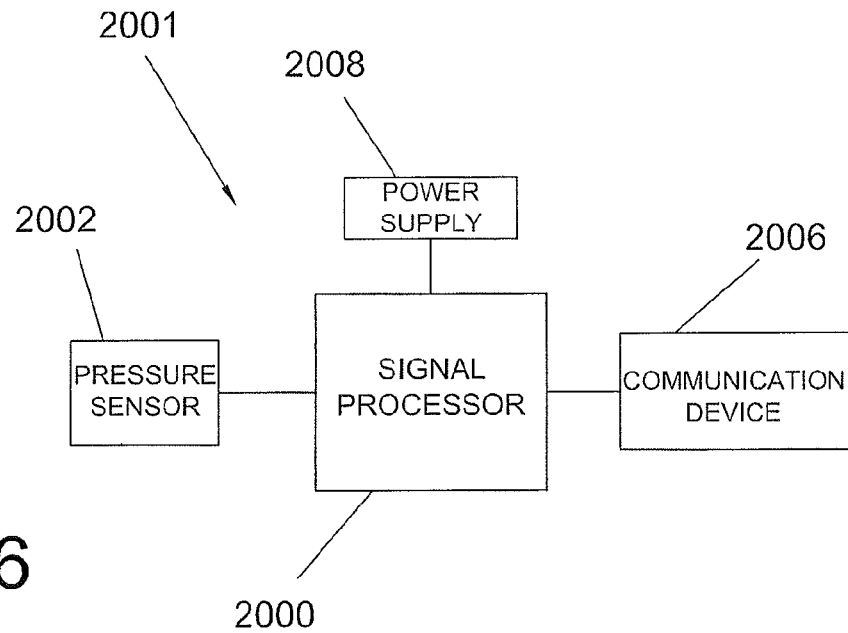


Fig. 26

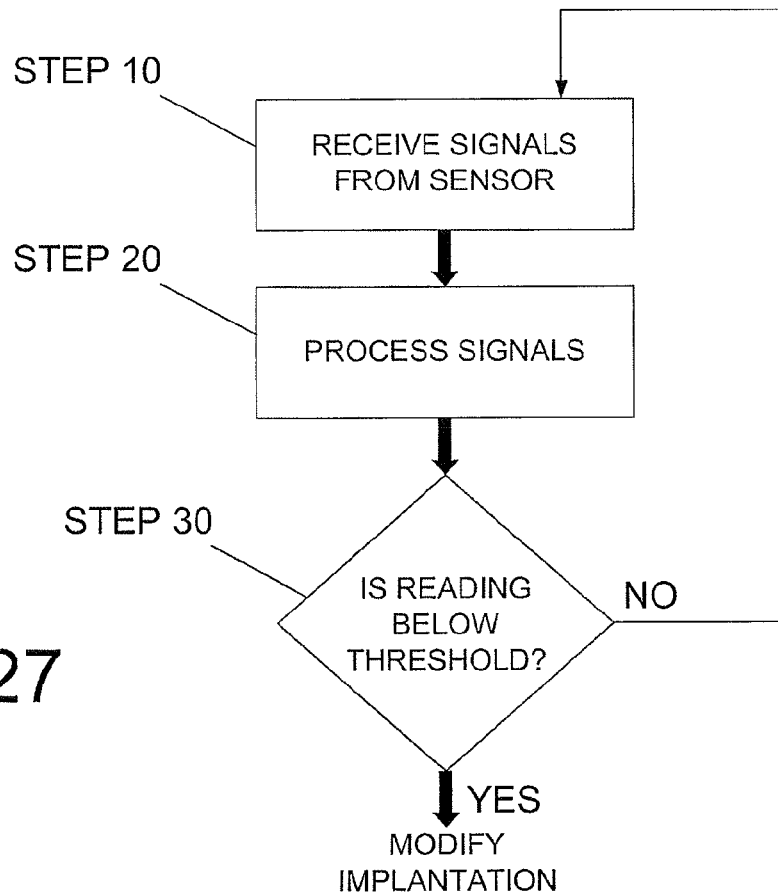


Fig. 27

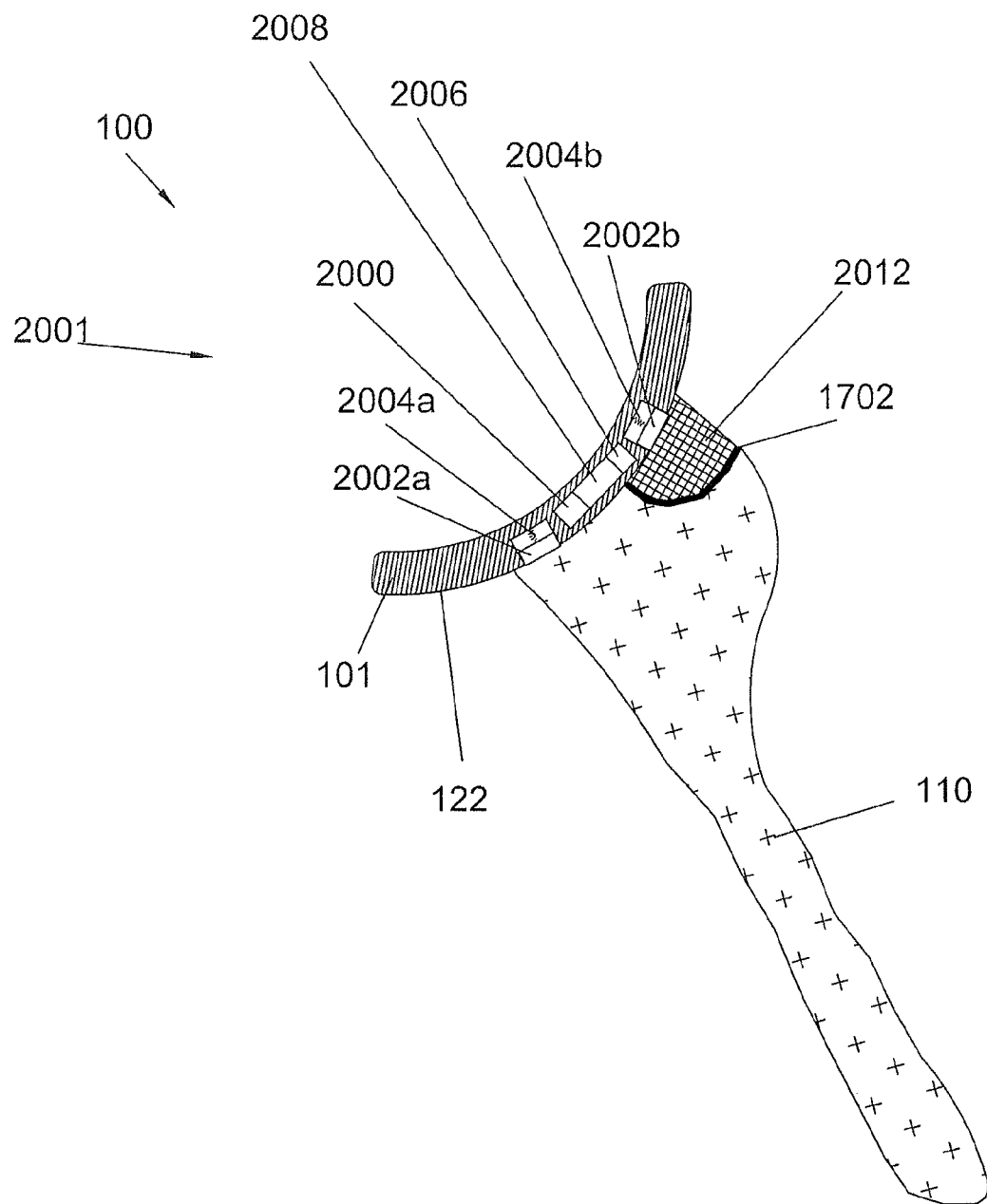
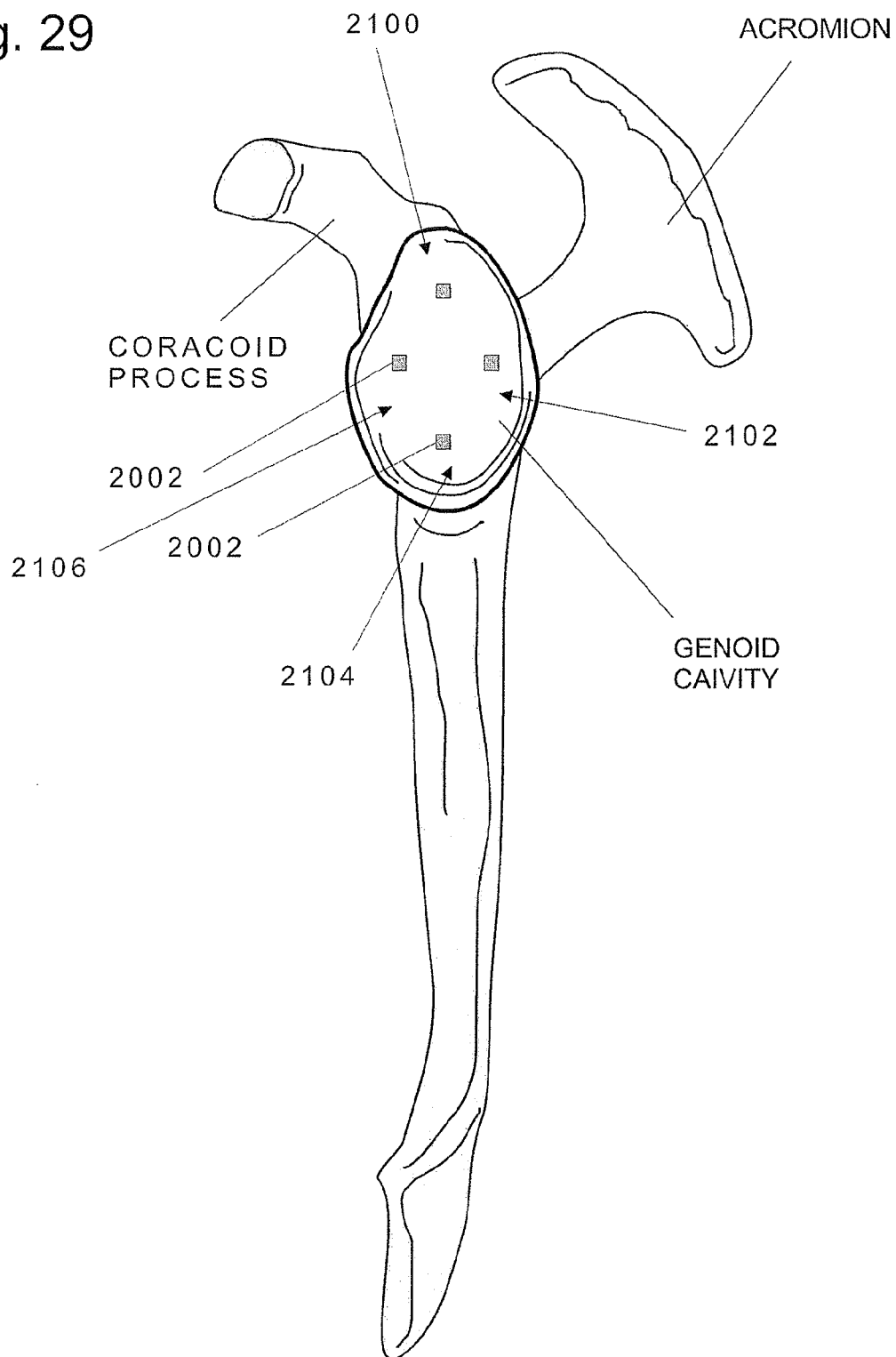


Fig. 28

Fig. 29



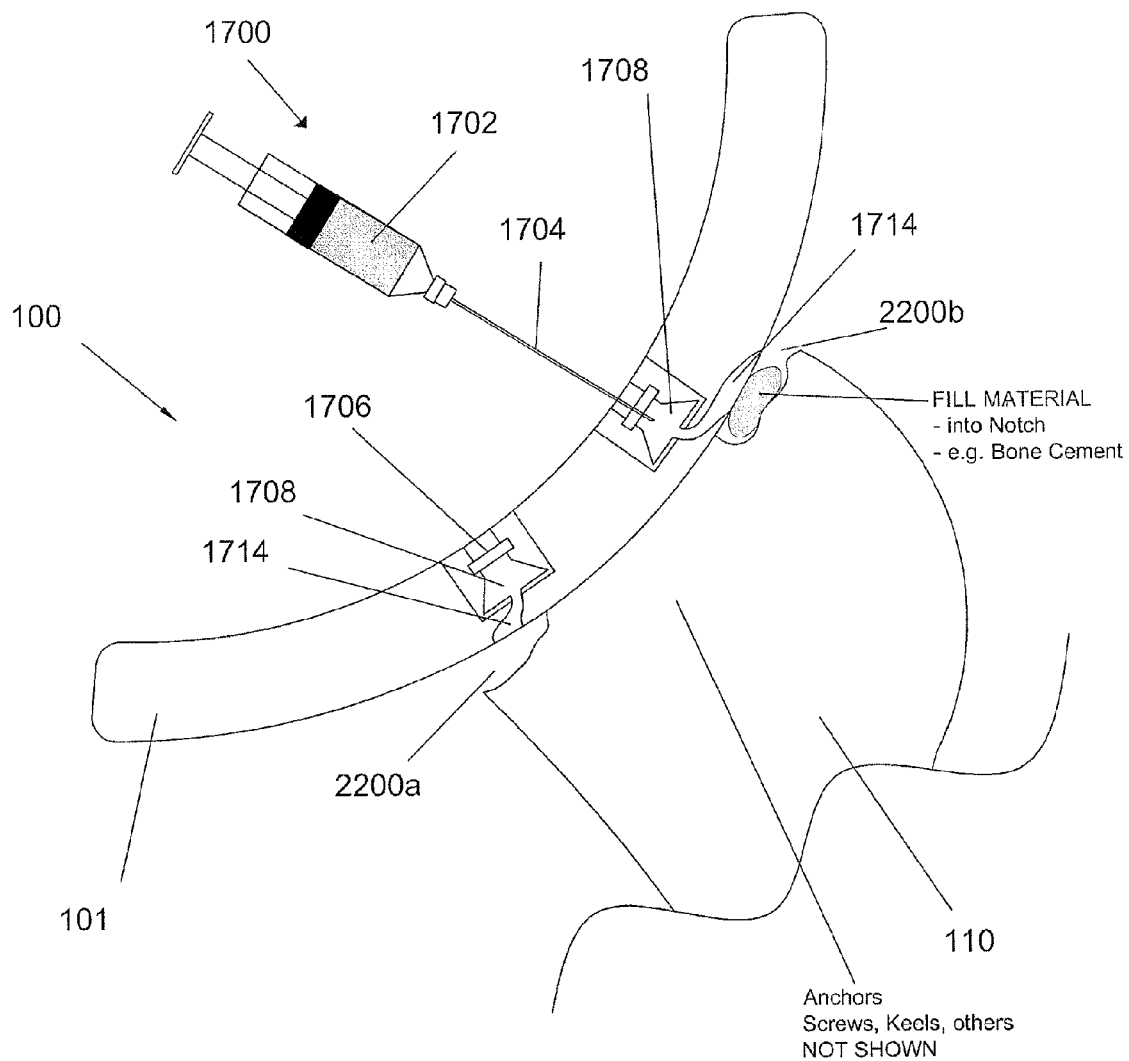


Fig. 30

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IMPLANTABLE SHOULDER PROSTHESES**RELATED APPLICATION**

The present application claims the benefit of U.S. Ser. No. 61/348,465, filed May 26, 2010, the content of which is incorporated herein by reference in its entirety.

FIELD OF THE APPLICATION

Embodiments of the present application relate generally to implantable prostheses, and more particularly, to implantable shoulder prostheses, methods of implanting shoulder prostheses and surgical tools for implanting shoulder prostheses.

BACKGROUND

Many joints of the human body naturally articulate relative to one another. Generally, the articulation surfaces of these joints are substantially smooth and without abrasion. However, joints, such as shoulder joints, undergo degenerative changes due to a variety of causes, such as, disease, injury, exercise and other strenuous activities, and various other issues. When these degenerative changes become advanced, to the point of becoming irreversible, such joints or portions thereof may need to be replaced with one or more prosthetics.

In light of the degenerative changes found in shoulder joints, various shoulder prosthetics of conventional design have been proposed. However, conventional shoulder prosthetics and their associated surgical components suffer from many disadvantages. For example, glenoid components of conventional design are subject to various types of load forces, such as, shear forces, anterior/posterior forces, lateral/medial forces, and rotational forces, which may cause notching and chipping of bone and/or loosening of the implanted components, thereby reducing the lifespan of the prosthetic. In addition, such load forces may create a rocking moment causing glenoid components to cantilever, which can further result in notching and chipping of bone and/or separation of the glenoid component from the scapula. Furthermore, the loosening of conventional shoulder prosthetics may pulverize, grind, crush and deform portions of a scapula, for example, a glenoid cavity of a scapula, which as a result, can prohibit the replacement of a worn, damaged or non-functional shoulder prosthetic. For these and other reasons, there is a need for improved shoulder prosthetics.

SUMMARY

Embodiments of the present application are directed toward implantable shoulder prostheses, methods of implanting shoulder prostheses and surgical tools for implanting shoulder prostheses that further address and reduce notching and chipping of bone and component loosening associated with implantable shoulder prosthetics. In particular, embodiments provide implantable shoulder prostheses and methods of implantation that realize, among other features, a dampening characteristic that reduces an applied load force through the absorption and dissipation of said force. Further embodiments provide, among other features, multiple fixation members for attaching implantable shoulder prosthesis and capabilities for attaching implantable shoulder prostheses to multiple surfaces of a scapula. Still further embodiments provide methods of manufacturing shoulder prosthesis including obtaining an image of a patient, such as an image including the contours of a patient's scapula, and manufacturing fixation members based on these contours. Although

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embodiments may be described with reference to shoulder prosthesis, joint components and methods for implantation described herein are applicable to other joints, such as hips, knees, elbows, wrists, digits and other joints. Patients applicable to these prosthetics include humans and other mammals, as well as other animalia.

In one aspect an implantable shoulder prosthesis comprises: a humeral member comprising: a humeral body comprising a humeral joint surface; and at least one humeral fixation member constructed and arranged to attach the humeral body to a humeral bone; a glenoid member comprising: a glenoid body comprising a glenoid joint surface; and at least one glenoid fixation member constructed and arranged to attach the glenoid body to a scapula; and a dampener; wherein the humeral joint surface and the glenoid joint surface are constructed and arranged to rotatably interface; and wherein the dampener is constructed and arranged to absorb a load force transferred to the at least one glenoid fixation member.

In some embodiments the implantable shoulder prosthesis is constructed and arranged to be implanted in a two legged mammal.

In some embodiments the humeral member comprises at least a portion of the dampener.

In some embodiments the dampener comprises a first portion and a second portion.

In some embodiments the at least one glenoid fixation member comprises the dampener second portion.

In some embodiments the humeral joint surface surrounds the glenoid joint surface such that movement of the humeral bone is at least partially constrained in two directions.

In some embodiments the humeral joint surface is rotatably connected to the glenoid joint surface such that the movement of the humeral bone is fully constrained in one direction and at least partially constrained along two axes.

In some embodiments the at least one humeral fixation member comprises a projecting stem.

In some embodiments the at least one humeral fixation member comprises a threaded projection.

In some embodiments the at least one humeral fixation member comprises a finned projection.

In some embodiments the at least one humeral fixation member is constructed and arranged to be secured within a humeral bone

In some embodiments the glenoid member comprises the dampener.

In some embodiments the dampener comprises a first portion and a second portion.

In some embodiments the humeral member comprises the dampener second portion.

In some embodiments the glenoid joint surface surrounds the humeral joint surface such that movement of the humeral bone is at least partially constrained in two directions.

In some embodiments the glenoid joint surface is concave.

In some embodiments the humeral joint surface is convex.

In some embodiments the glenoid joint surface is convex.

In some embodiments the humeral joint surface is concave.

In some embodiments the at least one glenoid fixation member extends into the scapula in a medial direction.

In some embodiments the at least one glenoid fixation member comprises at least one rigid portion.

In some embodiments the at least one glenoid fixation member comprises at least one flexible portion.

In some embodiments the at least one glenoid fixation member comprises at least one rigid portion and at least one flexible portion.

In some embodiments the at least one glenoid fixation member is selected from the group consisting of: a fin, a pin, a peg and a screw.

In some embodiments the at least one glenoid fixation member extends medially along one or more of: the anterior surface of the scapula and the posterior surface of the scapula.

In some embodiments the at least one glenoid fixation member comprises at least one attachment orifice.

In some embodiments at least one attachment device constructed and arranged to pass through the attachment orifice and into the scapula.

In some embodiments the at least one attachment device is selected from the group consisting of: a screw; a pin, a peg; a fin; and combinations thereof.

In some embodiments at least one attachment mechanism, the at least one attachment mechanism constructed and arranged to secure the at least one glenoid fixation member to the scapula.

In some embodiments the at least one attachment mechanism comprises a bone screw.

In some embodiments the at least one attachment mechanism comprises a molly bolt.

In some embodiments the at least one attachment mechanism comprises an attachment device selected from the group consisting of: a screw; a machine screw; a nut; a lock nut; a rivet; a bolt; a washer; and combinations thereof.

In some embodiments the dampener is positioned between the glenoid joint surface and the scapula.

In some embodiments the dampener is positioned between the at least one glenoid fixation member and the scapula.

In some embodiments the at least one glenoid fixation member comprises one or more of a pin, a peg, a screw and a fin, and wherein the dampener surrounds the at least one glenoid fixation member.

In some embodiments the dampener is positioned between the glenoid joint surface and the glenoid fixation member.

In some embodiments the glenoid member comprises a rigid section, and the dampener is positioned between the glenoid joint surface and the rigid section.

In some embodiments the at least one glenoid fixation member comprises at least two glenoid fixation members and the dampener is positioned between the glenoid joint surface and the at least two glenoid fixation members.

In some embodiments the at least one glenoid fixation member comprises a first rigid portion and a second rigid portion, and wherein the dampener is positioned between the first rigid portion and the second rigid portion.

In some embodiments the dampener is positioned between the humeral joint surface and the at least one humeral fixation member.

In some embodiments the dampener is positioned between the at least one humeral fixation member and the humeral bone.

In some embodiments the dampener surrounds at least a portion of the humeral fixation member.

In some embodiments the at least one humeral fixation member comprises a first rigid portion and a second rigid portion, wherein the dampener is positioned between the first rigid portion and the second rigid portion.

In some embodiments the dampener comprises a compressible material.

In some embodiments the dampener comprises a compressible assembly.

In some embodiments the compressible assembly comprises a pneumatic or hydraulic assembly.

In some embodiments the compressible assembly comprises a fluid filled reservoir.

In some embodiments the dampener comprises a spring.

In some embodiments the spring is selected from the group of springs consisting of: torsional, compression, constant force, Belleville, and combinations thereof.

In some embodiments the dampener comprises bone bonding material.

In some embodiments the bone bonding material is constructed and arranged to secure the humeral member to the humeral bone.

In some embodiments the bone bonding material surrounds at least a portion of the at least one humeral fixation member.

In some embodiments the bone bonding material secures the glenoid member to the glenoid cavity of the scapula.

In some embodiments the bone bonding material surrounds at least a portion of the at least one glenoid fixation member.

In some embodiments the bone bonding material comprises elastomeric material.

In some embodiments the bone bonding material comprises flexible bone cement.

In some embodiments the dampener comprises fill material.

In some embodiments the fill material is positioned in a space previously occupied by bone tissue.

In some embodiments the fill material comprises bone cement.

In some embodiments the fill material comprises flexible adhesive.

In some embodiments the flexible adhesive comprises elastomeric adhesive.

In some embodiments the dampener is further constructed and arranged to absorb a load force transferred to the at least one humeral fixation member.

In some embodiments the load comprises a compressive load.

In some embodiments the load comprises a torsional load.

In some embodiments the load comprises a relatively continuous load.

In some embodiments the load comprises a dynamic load.

In some embodiments the dampener comprises a first dampening portion and a second dampening portion.

In some embodiments the glenoid member comprises the first dampening portion and the humeral member comprises the second dampening portion.

In some embodiments the at least one glenoid fixation member comprises a first glenoid fixation member and a second glenoid fixation member and wherein the first dampening portion absorbs a load transferred to the first glenoid fixation member, and the second dampening portion absorbs a load transferred to the second glenoid fixation member.

In some embodiments the first dampening portion has a compression ratio greater than a compression ratio of the second dampening portion.

In some embodiments first dampening portion has a compression ratio equal to a compression ratio of the second dampening portion.

In some embodiments the first dampening portion is constructed and arranged to absorb a force applied in a first direction and the second dampening portion is constructed and arranged to absorb or reduce a force applied in a second direction.

In some embodiments the first direction and the second direction are different.

In another aspect an implantable shoulder prosthesis comprises: a glenoid member comprising: a glenoid body comprising a glenoid joint surface constructed and arranged to

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provide a bearing surface for a head portion of a humerus; a first glenoid fixation member constructed and arranged to attach the glenoid member to a scapula; and a second glenoid fixation member comprising an engageable attachment element constructed and arranged to further attach the glenoid member to the scapula; wherein said second glenoid fixation member attachment element is constructed and arranged to be engaged at least twenty four hours after implantation of the shoulder prosthesis.

In some embodiments the implantable shoulder prosthesis is constructed and arranged to be implanted in a two legged mammal.

In some embodiments the first glenoid fixation member is constructed and arranged to be engaged in a first internal portion of the scapula.

In some embodiments the second glenoid fixation member is constructed and arranged to be engaged in a second internal portion of the scapula.

In some embodiments the first glenoid fixation member is constructed and arranged to be engaged with the glenoid cavity of the scapula.

In some embodiments the second glenoid fixation member is constructed and arranged to be engaged with the glenoid cavity of the scapula.

In some embodiments the second glenoid fixation member is constructed and arranged to be engaged with one or more of: the anterior surface of the scapula and the posterior surface of the scapula.

In some embodiments the first glenoid fixation member is constructed and arranged to be engaged with one or more of: the anterior surface of the scapula and the posterior surface of the scapula.

In some embodiments the second glenoid fixation member is constructed and arranged to be engaged with the glenoid cavity of the scapula.

In some embodiments the second glenoid fixation member is constructed and arranged to be engaged with one or more of: the anterior surface of the scapula and the posterior surface of the scapula.

In some embodiments the first glenoid fixation member comprises the second glenoid fixation member.

In some embodiments the attachment element comprises an expandable member constructed and arranged to expand into bone.

In some embodiments the attachment element comprises an expandable member constructed and arranged to expand at least a portion of the first glenoid fixation member into bone.

In some embodiments the attachment element comprises an extendable member constructed and arranged to extend into bone.

In some embodiments the attachment element is positioned proximate the first glenoid fixation member.

In some embodiments the attachment element comprises an expandable member constructed and arranged to expand into bone.

In some embodiments the attachment element comprises an expandable member constructed and arranged to expand at least a portion of the first glenoid fixation member into bone.

In some embodiments the attachment element comprises an extendable member constructed and arranged to extend into bone.

In some embodiments the attachment element is positioned within the first glenoid fixation member.

In some embodiments the attachment element comprises an expandable member constructed and arranged to expand at least a portion of the first glenoid fixation member.

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In some embodiments the attachment element comprises an extendable member constructed and arranged to extend beyond the first glenoid fixation member and into bone.

In some embodiments the attachment element is an attachment device selected from the group consisting of: a fin; a pin; a peg; a screw; and combinations thereof.

In some embodiments the attachment element is constructed and arranged to rotate to attach the glenoid member to the scapula.

In some embodiments the attachment element is selected from the group consisting of: a pin, a peg, a screw, a fin and combinations thereof.

In some embodiments the attachment element comprises a sharpened distal end.

In some embodiments the attachment element comprises a proximal end constructed and arranged to removably engage with a tool.

In some embodiments said proximal end comprises one or more of a hexagonal shaped cavity, a slot, or two slots positioned approximately ninety degrees from each other.

In some embodiments the attachment element comprises an expandable portion.

In some embodiments an expansion tool construct and arranged to operably expand said expandable portion.

In some embodiments the expansion tool comprises an expandable balloon or an expandable cage.

In some embodiments the attachment element comprises a shape modifiable portion constructed and arranged to change shape to further attach the glenoid member to the scapula.

In some embodiments the shape modifiable portion comprises a least a plastically deformable material.

In some embodiments the shape modifiable portion comprises at least a shaped memory material.

In some embodiments the shape modifiable portion further comprises at least a plastically deformable material, and wherein the shaped memory material is constructed and arranged to deform the plastically deformable material at least twenty four hours after implantation of the shoulder prosthesis.

In some embodiments the attachment element is constructed and arranged to further attach the glenoid member to the scapula in the presence of a magnetic field.

In some embodiments the attachment element is constructed and arranged to further attach the glenoid member to the scapula in the presence of a temperature above body temperature.

In some embodiments the attachment element is constructed and arranged to automatically further attach the glenoid member to the scapula.

In some embodiments the attachment element is constructed and arranged to continuously further attach the glenoid member to the scapula.

In some embodiments the attachment element is constructed and arranged to further attach the glenoid member to the scapula based on a condition of the patient receiving the shoulder prosthesis.

In some embodiments the patient condition is loosening of the glenoid member.

In some embodiments the patient condition is the presence of a void in a bone of the patient.

In some embodiments the patient condition is suspected presence of a void in a bone of the patient.

In some embodiments the attachment element is biased with a constant force.

In some embodiments the implantable shoulder prosthesis further comprises an access port constructed and arranged for a tool to pass therethrough,

In some embodiments the access port is constructed and arranged to be accessed percutaneously.

In some embodiments the access port is constructed and arranged to be accessed in a minimally invasive procedure.

In some embodiments the access port is constructed and arranged to be accessed in an open surgical procedure.

In some embodiments the access port provides access to a portion of the first glenoid fixation member.

In some embodiments the access port provides access to a portion of the second glenoid fixation member.

In some embodiments the access port provides access to the attachment element.

In some embodiments the access port comprises a mechanical valve.

In some embodiments the mechanical valve is constructed and arranged to removably engage with the tool.

In some embodiments the access port comprises a resealable septum.

In some embodiments the septum is constructed and arranged to be penetrated by the tool avoiding removal of septum material.

In some embodiments the access port prevents biological or other contamination from passing through said access port.

In some embodiments the access port further comprises a transport tube wherein the tool can inject material through said transport tube.

In some embodiments the transport tube is constructed and arranged to have material delivered to a location between the glenoid member and the scapula.

In some embodiments the transport tube is constructed and arranged to have material delivered to a location selected from the group consisting of: within the glenoid member; proximate the glenoid member; and combinations thereof.

In some embodiments the transport tube is constructed and arranged to have material delivered to one or more of the first glenoid fixation member; the second glenoid fixation member; and the attachment element.

In some embodiments the material is selected from the group consisting of: adhesive; cement; saline; an agent such as a drug; and combinations thereof.

In some embodiments the material is fill material.

In some embodiments the fill material is constructed and arranged to expand at least a part of the glenoid member.

In some embodiments the fill material is constructed and arranged to expand the attachment element.

In some embodiments the fill material is constructed and arranged to fill a void in a bone.

In some embodiments the material is below body temperature.

In some embodiments the material is above body temperature.

In some embodiments the fill material transport tube of the resealable septum provides an access port through which fill material can be injected.

In some embodiments the implantable shoulder prosthesis further comprises an access port constructed and arranged for a tool to pass therethrough.

In some embodiments the access port comprises a resealable septum.

In some embodiments the access port comprises a mechanical valve.

In some embodiments the access port is constructed and arranged to be accessed percutaneously.

In some embodiments the fill material comprises a material selected from the group consisting of: adhesive, cement; and combinations thereof.

In some embodiments the fill material is flexible.

In some embodiments the fill material is rigid.

In some embodiments the tool comprises fill material constructed and arranged to fill a void in bone.

In some embodiments the first glenoid portion or the second glenoid portion comprise an expandable member and the fill material is constructed and arranged to expand the expandable member into bone.

In some embodiments the fill material is selected from the group consisting of: adhesive, cement, water, saline, antibiotics, and combinations thereof.

In some embodiments a tool.

In some embodiments the tool comprises a sharpened tip.

In some embodiments the tip is a needle tip.

In some embodiments the tip is a screwdriver tip.

In some embodiments the tool is constructed and arranged to inject material into or proximate the glenoid member.

In some embodiments said injected material is constructed and arranged to fill a space.

In some embodiments the space is space previously occupied by bone.

In some embodiments the injected material is selected from the group consisting of: adhesive; cement; saline; an agent such as a drug; and combinations thereof.

In some embodiments the material is delivered above body temperature.

In some embodiments the material is delivered below body temperature.

In some embodiments the tool is constructed and arranged to engage the attachment element.

In some embodiments the tool is further constructed and arranged to expand the attachment element.

In some embodiments the tool is further constructed and arranged to modify the shape of the attachment element.

In some embodiments the tool is further constructed and arranged to deliver energy to the attachment element.

In some embodiments the energy is selected from the group consisting of: magnetic energy; thermal energy; and combinations thereof.

In some embodiments the tool comprises a screwdriver.

In some embodiments the tool comprises a tip selected from the group consisting of: hex head; slotted head; Phillips head; and torque head.

In some embodiments the tip is sharp.

In some embodiments of the inventive concepts are directed to a method of implanting a shoulder prosthesis configured in accordance with embodiments described herein.

In another aspect an implantable shoulder prosthesis comprises: a glenoid member comprising: a glenoid joint surface that is constructed and arranged to provide a bearing surface for a head portion of a humerus; and a glenoid fixation member constructed and arranged to attach a scapula; a pressure sensing system configured to measure a pressure between the glenoid member and the scapula.

In some embodiments the scapula is within a two legged mammal.

In some embodiments a dampener.

In some embodiments the glenoid joint surface is concave.

In some embodiments the glenoid joint surface is convex.

In some embodiments the pressure sensing assembly comprises a sensor.

In some embodiments the sensor is selected from the group consisting of: a strain gauge; a force sensing resistor; a piezo crystal; and combinations thereof.

In some embodiments the sensor is positioned between the glenoid fixation member and the scapula.

In some embodiments the sensor is positioned on the surface of the scapula.

In some embodiments the sensor is positioned on the glenoid cavity.

In some embodiments the sensor is positioned on the anterior and/or posterior surface of the scapula.

In some embodiments the sensor is positioned on an internal portion of the scapula.

In some embodiments the pressure sensing system comprises a communication subsystem, wherein the communication subsystem is configured to generate a pressure sensor signal corresponding to the pressure measured between the glenoid facing surface of the glenoid member and a glenoid cavity of a scapula.

In some embodiments the communication subsystem comprises a wireless communication element.

In some embodiments the wireless communication element comprises a wireless transceiver operating on a frequency band selected from the group consisting of: 30-300 kHz, 300-3000 kHz, 3-30 MHz, 30-300 MHz, 300-3000 MHz, 3-30 GHz and 30-300 GHz.

In some embodiments the at least one attachment member comprises a pressure sensor, wherein the pressure sensor is operationally coupled to the pressure sensing system.

In some embodiments a biasing mechanism, wherein the biasing mechanism biases the pressure sensor in an outward direction from the glenoid facing surface.

In some embodiments the outward direction is a medial direction.

In some embodiments the biasing mechanism is a spring.

In some embodiments the biasing mechanism is selected from the group consisting of: a rubber plug, a foam plug and a plastic plug.

In another aspect an implantable shoulder prosthesis, comprises: a glenoid member comprising: a glenoid joint surface; and at least one glenoid fixation member attached to the glenoid member, the at least one glenoid fixation member comprising an elongated arm extending from the glenoid member to a location on a scapular surface, said scapular surface comprising an anterior, posterior or both anterior and posterior surface of the scapula.

In some embodiments the implantable shoulder prosthesis is constructed and arranged to prevent the scapula from fracture.

In some embodiments the implantable shoulder prosthesis is implantable in a two legged mammal.

In some embodiments the implantable shoulder prosthesis is implantable in a human being.

In some embodiments the implantable shoulder prosthesis is constructed and arranged to be of a size for being implantable in a human being.

In some embodiments the glenoid member further comprises a medial surface opposite the glenoid joint surface.

In some embodiments the medial surface is constructed and arranged to contact a glenoid cavity of a mammalian scapula.

In some embodiments the glenoid member comprises at least one fin projecting from the medial surface.

In some embodiments the glenoid member comprises at least one peg projecting from the medial surface.

In some embodiments the glenoid member comprises at least one peg projecting from the medial surface.

In some embodiments the glenoid member comprises a material selected from the group of materials consisting of: cobalt-chrome; titanium; stainless steel; tantalum; polyethylene; silicon; nylon; and combinations thereof.

In some embodiments the glenoid member comprises a laminated construction.

In some embodiments said laminated construction comprises at least two materials selected from the group of materials consisting of: cobalt-chrome; titanium; stainless steel; tantalum; polyethylene; silicon; nylon; plastic; elastomer; silicone; and combinations thereof.

In some embodiments said laminated construction comprises at least a compressible material and an incompressible material.

In some embodiments the glenoid member comprises a first portion and a second portion, the first portion comprising the glenoid joint surface and the second portion comprising a surface opposite the glenoid joint surface.

In some embodiments the first portion is fixedly attached to the second portion.

In some embodiments the first portion of the glenoid member is a replaceable element.

In some embodiments the glenoid member comprises a first portion and a second portion connected together via a hinge.

In some embodiments the hinge extends in a superior-inferior direction.

In some embodiments the hinge extends in an anterior-posterior direction.

In some embodiments the hinge is constructed and arranged to allow a head of a humerus to dislocate prior to causing a fracture in the implantable shoulder prosthesis or the scapula.

In some embodiments the first portion and the second portion flex about a longitudinal axis of the hinge.

In some embodiments the hinge is positioned at a central portion of the glenoid member.

In some embodiments the hinge comprises a rubber material.

In some embodiments the hinge is constructed and arranged to prevent fracture of the scapula.

In some embodiments the glenoid member comprises a first portion, a second portion, a third portion and a fourth portion, wherein each of the first through fourth portions are connected together via a hinge.

In some embodiments the hinge comprises a first hinge portion that extends in a superior-inferior direction and a second hinge portion that extends in an anterior-posterior direction.

In some embodiments a torsional stiffness of the first hinge portion is greater than a torsional stiffness of the second hinge portion.

In some embodiments the glenoid joint surface of the glenoid member is constructed and arranged to provide a bearing surface for a head portion of a humerus.

In some embodiments the head portion of the humerus is an artificial implant.

In some embodiments the glenoid joint surface of the glenoid member is concave.

In some embodiments the glenoid joint surface of the glenoid member is convex.

In some embodiments the glenoid joint surface of the glenoid member comprises a concave cross section relative to a superior-inferior direction of extension.

In some embodiments the humeral head surface of the glenoid member comprises a concave cross section relative to an anterior-posterior direction of extension.

In some embodiments the humeral head surface of the glenoid member comprises a concave cross section relative to a superior-inferior direction of extension and an anterior-posterior direction of extension.

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In some embodiments the at least one glenoid fixation member is constructed and arranged to prevent the scapula from fracture.

In some embodiments the at least one glenoid fixation member is constructed and arranged to hold fractured portions of the scapula together.

In some embodiments the at least one glenoid fixation member is less than about 10 cm in length.

In some embodiments the at least one glenoid fixation member is less than about 15 cm in length.

In some embodiments the at least one glenoid fixation member is less than about 20 cm in length.

In some embodiments the at least one glenoid fixation member comprises a material selected from the group of materials consisting of: cobalt-chrome; titanium; stainless steel; tantalum; polyethylene; silicon; nylon; and combinations thereof.

In some embodiments the glenoid member and the at least one glenoid fixation member comprise materials each having a different stiffness.

In some embodiments the implantable shoulder prosthesis is at least one attachment mechanism, the at least one attachment mechanism constructed and arranged to secure the at least one glenoid fixation member to the scapular surface.

In some embodiments the at least one attachment mechanism comprises a bone screw.

In some embodiments the at least one attachment mechanism comprises a molly bolt.

In some embodiments the at least one attachment mechanism comprises an attachment mechanism selected from the group consisting of: a screw; a machine screw; a nut; a lock nut; a rivet; a bolt; a washer; and combinations thereof.

In some embodiments the at least one attachment mechanism comprises a material selected from the group of materials consisting of: cobalt-chrome; titanium; stainless steel; tantalum; polyethylene; silicone; nylon; and combinations thereof.

In some embodiments the at least one glenoid fixation member is removably attached to the glenoid member.

In some embodiments the at least one glenoid fixation member is attached to a central region of the glenoid side surface of the glenoid member.

In some embodiments the at least one glenoid fixation member is attached to an off-central region of the glenoid surface of the glenoid member.

In some embodiments the at least one glenoid fixation member is attached to an outer side surface of the glenoid member.

In some embodiments a side surface of the at least one glenoid fixation member is aligned with an outer side surface of the glenoid member.

In some embodiments the at least one glenoid fixation member comprises a first fixation member and a second fixation member.

In some embodiments the first fixation member is secured to the anterior surface of the scapula and the second fixation member is secured to the posterior surface of the scapula.

In some embodiments the first and second fixation members each comprise at least one attachment orifice constructed and arranged to receive an attachment mechanism.

In some embodiments the at least one attachment orifice of each of the first and second fixation members is aligned with each other.

In some embodiments the implantable shoulder prosthesis is an attachment mechanism, wherein the attachment mechanism is constructed and arranged to engage the at least one attachment orifice of each of the first and second stabilizing

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members to secure the first and second stabilizing members to the opposing anterior and posterior surfaces of the scapula.

In some embodiments the at least one glenoid fixation member comprises at least a rigid portion.

In some embodiments the at least one glenoid fixation member comprises at least a semi-rigid portion.

In some embodiments the at least one glenoid fixation member comprises at least a flexible portion.

In some embodiments the at least one glenoid fixation member comprises at least a rigid portion and a non-rigid portion.

In some embodiments the elongated arm of the at least one glenoid fixation member is constructed and arranged to conform to the scapular surface.

In some embodiments the scapula is a human scapula.

In some embodiments the at least one glenoid fixation member is machined to approximate the contour of the scapula.

In some embodiments the at least one glenoid fixation member is machined based on a patient image.

In some embodiments the patient image is selected from the group consisting of: X-Ray; CtScan; MRI; Nuclear Image; Ultrasound Image; Electromagnetic Image; and combinations thereof.

In some embodiments the at least one glenoid fixation member comprises at least a rigid portion.

In some embodiments the at least one glenoid fixation member comprises at least a flexible portion.

In some embodiments the at least one glenoid fixation member comprises at least a malleable portion.

In some embodiments the at least a malleable portion is constructed and arranged to be plastically deformed prior to attaching the at least one glenoid fixation member to the scapula.

In some embodiments the at least one glenoid fixation member comprises a rubber coating.

In some embodiments the at least one glenoid fixation member comprises a laminated construction.

In some embodiments said laminated construction comprises at least two materials selected from the group of materials consisting of: cobalt-chrome; titanium; stainless steel; tantalum; polyethylene; silicon; nylon; plastic; elastomer; silicone; and combinations thereof.

In some embodiments said laminated construction comprises at least a compressible material and an incompressible material.

In some embodiments the implantable shoulder prosthesis has at least one attachment element protruding from the at least one glenoid fixation member.

In some embodiments the attachment element is integral with the at least one glenoid fixation member.

In some embodiments the at least one glenoid fixation member comprises at least one attachment orifice constructed and arranged to receive an attachment mechanism.

In some embodiments the implantable shoulder prosthesis has at least one attachment mechanism, wherein the at least one attachment mechanism is constructed and arranged to engage the at least one attachment orifice to secure the at least one glenoid fixation member to the scapular surface.

In some embodiments the at least one attachment orifice comprises a first attachment orifice and a second attachment orifice.

In some embodiments the first attachment orifice and the second attachment orifice are spaced apart from each other.

In some embodiments the at least one attachment orifice comprises a screw hole.

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In some embodiments the at least one attachment orifice comprises a first attachment orifice and a second attachment orifice, and wherein the elongated arm comprises first and second arm portions that each extend from the elongated arm.

In some embodiments the first attachment orifice is positioned along the first arm portion and the second attachment orifice is positioned along the second arm portion.

In some embodiments a planar surface of the first arm portion is offset from a planar surface of the second arm portion.

In some embodiments the implantable shoulder prosthesis is an adhesive material.

In some embodiments the adhesive material secures the at least one fixation member to the scapular surface.

In some embodiments the implantable shoulder prosthesis is at least one attachment mechanism, the at least one attachment mechanism constructed and arranged to further secure the at least one glenoid fixation member to the scapular surface.

In some embodiments the adhesive material secures the glenoid member to a glenoid cavity of the scapula.

In some embodiments the adhesive resides between the second surface and the glenoid cavity.

In some embodiments the glenoid member comprises at least one projection extending from the second surface, and wherein the adhesive surrounds the projection.

In some embodiments the adhesive material is a glue material.

In some embodiments the adhesive material is a cement material.

In some embodiments the implantable shoulder prosthesis is at least one cushion member connected to the at least one glenoid fixation member.

In some embodiments the at least one cushion member comprises a material selected from the group consisting of: a foam material; a rubber material; a plastic material; and combinations thereof.

In some embodiments the glenoid member has an anterior end and a posterior end, said prosthesis further comprising a bioabsorbable constraint member extending from said glenoid member anterior end or said glenoid member posterior end, wherein the bioabsorbable constraint member bioabsorbs when present in a human body.

In some embodiments the bioabsorbable constraint member limits rotation of a humerus bone.

In some embodiments the bioabsorbable constraint member increases rotational movement of the humerus bone in proportion to the bioabsorption of the bioabsorbable constraint member.

In some embodiments the bioabsorbable constraint member increases rotational movement of the humerus bone when the bioabsorbable constraint member is bioabsorbed.

In some embodiments the bioabsorbable constraint member bioabsorbed over a period of at least one week.

In some embodiments the bioabsorbable constraint member bioabsorbs over a period of at least one month.

In some embodiments the bioabsorbable constraint member bioabsorbs over a period of at least six months.

In some embodiments the bioabsorbable constraint member comprises a first bioabsorbable portion and a second bioabsorbable portion.

In some embodiments the first bioabsorbable portion and the second bioabsorbable portion have different rates of bioabsorption.

In some embodiments the implantable shoulder prosthesis is a coating.

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In some embodiments the coating is constructed and arranged to promote tissue ingrowth and/or prevent wear.

In some embodiments the implantable shoulder prosthesis is glenoid bulking material.

In some embodiments the bulking material is selected from the group consisting of: bone; foam; plastic; cement; metal; and combinations thereof.

In some embodiments the implantable shoulder prosthesis is a support member attached on and/or near the glenoid cavity.

In some embodiments the implantable shoulder prosthesis is an attachment tool.

In some embodiments the attachment tool comprises a right angle screwdriver.

In some embodiments the attachment tool is powered.

In some embodiments the attachment tool comprises a wrench.

In some embodiments the handle is a curvilinear handle.

In some embodiments the handle is malleable.

In some embodiments the implantable shoulder prosthesis is a humeral implant.

In some embodiments the humeral implant comprises a convex mating surface.

In some embodiments the humeral implant comprises a concave surface.

In some embodiments the implantable shoulder prosthesis is a securing assembly constructed and arranged to attach tissue to at least one glenoid fixation member.

In some embodiments the tissue comprises rotator cuff tissue.

In some embodiments the securing assembly is constructed and arranged to allow suture to pass therethrough.

In some embodiments the securing assembly comprises a loop.

In some embodiments the securing assembly comprises mesh.

In some embodiments the mesh is Dacron mesh.

In another aspect a method of manufacturing an implantable shoulder prosthesis comprises: providing a glenoid member having a lateral facing surface and a medial facing surface; imaging a topography of a scapula; and forming at least one stabilizing member based on the topography of a scapula, wherein the at least one stabilizing member is attached to the glenoid member.

In some embodiments the at least one stabilizing member comprises an elongated arm extending from the glenoid member in a direction transverse to the medial facing surface.

In some embodiments the imaging of the topography of a scapula is performed by a magnetic resonance imaging system.

In some embodiments the imaging of the topography of a scapula is performed by a computed tomography imaging system.

In some embodiments the imaging of the topography of a scapula is performed by an imaging system selected from the group consisting of: computed tomography; X-ray; NMR; MRI; ultrasound imaging device; infrared imaging device; and combinations thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the invention will be apparent from the more particular description of preferred embodiments, as illustrated in the accompanying drawings in which like reference characters refer to the same parts throughout the different views. The

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drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the preferred embodiments.

FIG. 1A is an anterior facing environmental view of a left shoulder joint;

FIG. 1B is a posterior facing environmental view of a left shoulder joint;

FIG. 1C is a lateral/medial facing view of a scapula;

FIG. 2 is an anterior facing environmental view of an implantable shoulder prosthesis comprising a dampener in accordance with embodiments of the present invention;

FIG. 3A is a side view of an implantable shoulder prosthesis comprising a dampener in accordance with embodiments of the present invention, and FIG. 3B is an exploded side view of the implantable shoulder prosthesis of FIG. 3A in accordance with embodiments of the present invention;

FIG. 3C is a side view of an implantable shoulder prosthesis comprising a replaceable glenoid joint surface in accordance with embodiments of the present invention;

FIG. 4 is a side view of an implantable shoulder prosthesis comprising a humeral prosthetic having a dampener in accordance with embodiments of the present invention;

FIG. 5 is a side view of an implantable shoulder prosthesis comprising a plurality of fixation members in accordance with embodiments of the present invention;

FIG. 6a is a side view of an implantable shoulder prosthesis comprising an articulating glenoid joint member in accordance with embodiments of the present invention, and FIG. 6b is a side view of the implantable shoulder prosthesis of FIG. 6a illustrating an applied load force;

FIG. 7 is a top perspective view of an implantable shoulder prosthesis comprising a dampening system in accordance with embodiments of the present invention;

FIG. 8 is an anterior facing environmental view of an implantable shoulder prosthesis comprising a dampener and an extending glenoid fixation member, in accordance with embodiments of the present invention;

FIGS. 9a and 9b are 3-dimensional views of an implantable shoulder prosthesis in accordance with embodiments of the present invention;

FIGS. 10a and 10b are top perspective views of an implantable shoulder prosthesis in accordance with embodiments of the present invention;

FIG. 11 is top perspective view of an implantable shoulder prosthesis comprising a hinge in accordance with embodiments of the present invention;

FIGS. 12a, 12b and 12c illustrate a plurality of hinge configurations of the glenoid joint surface of the implantable shoulder prosthesis of FIG. 11 in accordance with embodiments of the present invention;

FIGS. 13a and 13b are top perspective views of an implantable shoulder prosthesis in accordance with embodiments of the present invention;

FIG. 14 is a top perspective view of an implantable shoulder prosthesis in accordance with embodiments of the present invention;

FIG. 15 is a top perspective view of an implantable shoulder prosthesis in accordance with embodiments of the present invention;

FIG. 16 is an anterior facing environmental view of an implantable shoulder prosthesis in accordance with embodiments of the present invention;

FIG. 17 is an anterior facing environmental view of a constrained implantable shoulder prosthesis comprising a dampener in accordance with embodiments of the present invention;

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FIG. 18 is a top perspective view of an implantable shoulder prosthesis in accordance with embodiments of the present invention;

FIG. 19 is a top perspective view of an implantable shoulder prosthesis and surgical tools for implanting the shoulder prosthesis in accordance with embodiments of the present invention;

FIG. 20 is a top perspective view of a constrained implantable shoulder prosthesis in accordance with embodiments of the present invention;

FIG. 21 is a top perspective view of an implantable shoulder prosthesis in accordance with embodiments of the present invention;

FIGS. 22a and 22b are cross-sectional views of a glenoid member having expandable glenoid fixation members in accordance with embodiments of the present invention;

FIGS. 23a, 23b, 23c and 23d are cross-sectional views of a glenoid member having expandable glenoid fixation members in accordance with embodiments of the present invention;

FIG. 24 is a top perspective view of an implantable shoulder prosthesis comprising a plurality of glenoid fixation members each having an access port through which an adhesive material can be added in accordance with embodiments of the present invention;

FIGS. 25a, 25b and 25c are top perspective views of an implantable shoulder prosthesis comprising a plurality of glenoid fixation members in which subsets of the plurality of glenoid fixation members are engaged during separate procedures in accordance with embodiments of the present invention;

FIG. 26 is a block diagram of a pressure sensing system in accordance with embodiments of the present invention;

FIG. 27 is a flow diagram illustrating a method of operating a pressure sensing system in accordance with embodiments of the present invention;

FIG. 28 is a top perspective view of an implantable shoulder prosthesis comprising a pressure sensing system in accordance with embodiments of the present invention;

FIG. 29 is a lateral/medial facing view of a scapula illustrating pressure sensor locations in accordance with embodiments of the present invention;

FIG. 30 is a top perspective view of an implantable shoulder prosthesis comprising a plurality of access ports through which an adhesive material can be added in accordance with embodiments of the present invention.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS

Embodiments of the invention are described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. The present invention may, however, be embodied in many different forms and should not be construed as limited to the example embodiments set forth herein. Rather, these exemplary embodiments are provided so that this disclosure will be thorough and complete. In the drawings, the sizes and relative sizes of objects may be exaggerated for clarity.

It will be understood that when an element or object is referred to as being “on,” “connected to” or “coupled to” another element or object, it can be directly on, connected or coupled to the other element or object, or intervening elements or objects may be present. In contrast, when an element is referred to as being “directly on,” “directly connected to” or “directly coupled to” another element or object, there are no intervening elements or objects present. As used herein, the

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term “and/or” includes any and all combinations of one or more of the associated listed items.

It will be understood that, although the terms first, second, etc. are used herein to describe various elements, these elements should not be limited by these terms. These terms are used to distinguish one element from another. For example, a first element could be termed a second element, and, similarly, a second element could be termed a first element, without departing from the scope of the present invention. As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present invention. As used herein, the singular forms “a,” “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises” and/or “comprising,” when used in this specification, specifically the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

FIG. 1a is an anterior facing environmental view of a shoulder joint, FIG. 1b is a posterior facing environmental view of a shoulder joint, and FIG. 1c is a lateral/medial facing view of a scapula. In human anatomy, a shoulder joint comprises the part of the body where a humeral bone (i.e., humerus) attaches to a shoulder blade (i.e., scapula). The humerus comprises a humeral head portion that interfaces with a glenoid cavity of a scapula, such that the humerus articulates with respect to the glenoid cavity of the scapula. The scapula forms the posterior located part of the shoulder girdle.

For purposes of the present disclosure, the terms “sagittal plane” and the like, when referring to portions of the human body, refers to an imaginary plane that travels vertically from the top to the bottom of the body, dividing the body into left and right portions.

For purposes of the present disclosure, the terms “coronal plane”, “frontal plane” and the like, when referring to portions of the human body, refers to an imaginary plane that travels vertically from the top to the bottom of the body, dividing the body into anterior and posterior (e.g., belly and back) portions.

For purposes of the present disclosure, the terms “medial”, “medial direction” and the like, when referring to anatomical terms of direction, refers to a direction that is transverse to the sagittal plane of a human body, and that extends in a direction toward the sagittal plane of a human body.

For purposes of the present disclosure, the terms “lateral”, “lateral direction” and the like, when referring to anatomical terms of direction, refers to a direction that is transverse to the sagittal plane of a human body, and that extends in a direction away from the sagittal plane of a human body.

For purposes of the present disclosure, the terms “superior/inferior”, “superior/inferior direction” and the like, when referring to anatomical terms of direction, refers to a direction that extends in upward and downward directions, through a superior angle of a scapula and an inferior angle of a scapula.

For purposes of the present disclosure, the terms “superior”, “superior direction” and the like, when referring to anatomical terms of direction, refers to a direction that extends upward, through a superior angle of a scapula.

For purposes of the present disclosure, the terms “inferior”, “inferior direction” and the like, when referring to anatomical terms of direction, refers to a direction that extends downward, through an inferior angle of a scapula.

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FIG. 2 is an anterior facing environmental view of an implantable shoulder prosthesis comprising a dampener in accordance with embodiments of the present invention. A shoulder prosthesis 100 can comprise a glenoid member 101 having a glenoid joint member 103 and at least one glenoid fixation member 106.

The glenoid fixation member 106 can be constructed and arranged to attach the glenoid member 101 to a glenoid cavity of a scapula 110. For example, the glenoid fixation member 106 can extend from a medial face 122 of the glenoid member 101 in a medial direction MD, and may comprise a fin, a pin, a peg or a screw. Further, the glenoid fixation member 106 can be integral with the glenoid member 101, or may be a separate piece connected thereto. The glenoid fixation member 106 or portions thereof can be surrounded by a dampening material 108, which can absorb and dissipate an applied load force, thus reducing notching and chipping of bone and component loosening associated with the implantable shoulder prosthesis 100. In some embodiments, glenoid fixation member 106 is 10 cm, 15 cm, or 20 cm in length.

In one embodiment, a fin, such as a glenoid fin known to those of skill in the art, can be used to attach the glenoid member 101 to a scapula 110. In another embodiment, a pin, such as a glenoid pin known to those of skill in the art, can be used to attach the glenoid member 101 to a scapula 110. In another embodiment, a peg, such as a glenoid peg known to those of skill in the art, can be used to attach the glenoid member 101 to a scapula 110. In another embodiment, a screw, such as a glenoid screw known to those of skill in the art, can be used to attach the glenoid member 101 to a scapula 110.

The glenoid member 101 can further comprise a dampener 104, which is constructed and arranged to absorb a load force 116 transferred to the glenoid fixation members 106. In one embodiment, the dampener 104 absorbs a load force 116 applied to a glenoid joint surface 102 of the glenoid joint member 103, such that, a reduced load force is transferred to the glenoid fixation members 106. As a result of the dampening of the load force 116, notching and chipping of bone and component loosening associated with the implantable shoulder prosthesis 100 is reduced.

The dampener 104 may comprise a compressible material, for example, a rubber compound, plastic compound, a foam material, a silicon material and the like. The dampener 104 can further comprise a bone bonding material, which can be used to secure the glenoid joint member 103 to a glenoid cavity of a scapula 110. In one embodiment, the bone bonding material can comprise an elastomeric material. In another embodiment, the bone bonding material can comprise a flexible cement, such as the flexible bone composite disclosed in U.S. Ser. No. 11/148,193, filed on Jun. 9, 2005, by Kerr, et al., the content of which is incorporated herein by reference. In addition, the bone bonding material can be used to attach various components of a shoulder prosthesis to a humeral bone or a scapula 110.

The glenoid joint surface 102 of the glenoid joint member 103 can be constructed and arranged provide a bearing surface for a head portion 120 of a humeral member 118. The head portion 120 can comprise an artificial humeral head prosthetic or a humeral head of a human humeral bone.

In one embodiment, the glenoid joint surface 102 of the glenoid joint member 103 is concave, such that, the glenoid joint surface 102 is constructed and arranged to interface with a convex humeral joint surface of a head portion 120 of a humeral member 118. In another embodiment, the glenoid joint surface 102 of the glenoid joint member is convex, such that, the glenoid joint surface 102 is constructed and arranged

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to interface with a concave humeral joint surface of a head portion **120** of a humeral member **118** (e.g., reverse shoulder prosthetic). In these embodiments, the humeral member **118** can comprise a humeral bone of a human being or an artificial humeral prosthetic, or combination thereof.

In some embodiments, prosthesis **100** can include a coating, not shown but typically on one or more portions of prosthesis **100** outer surface. The coating can be selected from the group consisting of: a lubricous, an anti-rejection agent, an anti-inflammatory agent, an anti-bacterial coating; and combinations of these. Additionally, one or more coatings can be included to promote bone ingrowth and/or prevent wear.

FIG. **3a** is a side view of an implantable shoulder prosthesis comprising a dampener in accordance with embodiments of the present invention, and FIG. **3b** is an exploded side view of the implantable shoulder prosthesis of FIG. **3a** in accordance with embodiments of the present invention. In one embodiment, a glenoid member **101** of a shoulder prosthesis **100** comprises a glenoid joint member **103** and a dampener **104** having a first dampening portion **124** and a second dampening portion **126**.

In one embodiment, the first dampening portion **124** comprises a compression ratio greater than a compression ratio of the second dampening portion **126**. In another embodiment, the first dampening portion **124** comprises a compression ratio less than a compression ratio of the second dampening portion **126**. In another embodiment, the first dampening portion **124** comprises a compression ratio equal to a compression ratio of the second dampening portion **126**.

The first dampening portion **124** and the second dampening portion **126** may comprise a compressible material, for example, a rubber compound, plastic compound, a foam material, a silicon material and the like. In one embodiment, the first dampening portion **124** comprises a compressible material different from a material of the second dampening portion **126**.

The shoulder prosthesis **100** may further comprise a glenoid fixation member **106** that is constructed and arranged to attach the glenoid member **101** to a scapula **110**. In this embodiment, the glenoid fixation member **106** comprises a rotatable anchor; however, other types glenoid fixation members **106** may be used to attach the glenoid member **101** to a scapula **110**.

FIG. **3c** is a side view of an implantable shoulder prosthesis comprising a replaceable glenoid joint surface in accordance with embodiments of the present invention. In this embodiment, a glenoid member **101** of a shoulder prosthesis **100** comprises a glenoid joint member **103** that is removably attached to a rigid glenoid component **128**. The glenoid joint member **103** can be attached to the rigid glenoid component **128** by a screw **130**. Other means for attaching the glenoid joint member **103** to the rigid glenoid component can be used, for example, hooks, clips, adhesives, engaging surfaces, and the like. The glenoid member **101** may further comprise a dampener **104** positioned between the glenoid joint member **103** and the rigid glenoid component **128**. In this embodiment, the glenoid fixation member **106** comprises a fin; however, other types glenoid fixation members **106** may be used to attach the glenoid member **101** to a scapula **110**.

FIG. **4** is a side view of an implantable shoulder prosthesis comprising a humeral prosthetic having a dampener in accordance with embodiments of the present invention. A shoulder prosthesis **100** can comprise an implantable humeral head **402** adapted to interface with a glenoid joint of a scapula. The glenoid joint can comprise an implantable glenoid component or a glenoid cavity of a human scapula.

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In one embodiment, the humeral head **402** comprises a first head portion **404** and a second head portion **406**. The humeral head **402** can further comprise a dampener **104a** connected between the first head portion **404** and the second head portion **406** of the humeral head **402**. The humeral head **402** can be further connected to a humeral stem **412** at a connection rod **414**. In one embodiment, the connection rod **414** comprises a dampener **104b**.

The humeral stem **412** can be implanted in a humerus **118**, and secured therein with an adhesive material **410**. In one embodiment, the adhesive material **410** comprises a flexible dampening material, an adhesive cement, an adhesive glue and the like.

In these embodiments, the dampeners **104a** and **104b** and the dampening material **410** can reduce a load force transferred to a glenoid joint of a scapula, thus reducing notching and chipping of bone and component loosening associated with the implantable shoulder prosthesis **100**.

FIG. **5** is a side view of an implantable shoulder prosthesis comprising a plurality of fixation members in accordance with embodiments of the present invention. An implantable shoulder prosthesis **100** can further comprise a glenoid member **101** and a plurality of glenoid fixation members **106**. The glenoid fixation members can extend into a scapula **110** in a medial direction MD.

In this embodiment, the glenoid fixation member **106** comprises a spring **500**, which is capable of absorbing and dissipating an applied load force **116**. In one embodiment, the spring **500** is integral with the glenoid fixation member **106**; however, in other embodiments, the spring **500** can be separate from the glenoid fixation member **106**. As a result, the glenoid fixation member **106** can comprise a rigid portion and a flexible portion.

FIG. **6a** is a side view of an implantable shoulder prosthesis comprising an articulating glenoid joint member in accordance with embodiments of the present invention, and FIG. **6b** is a side view of the implantable shoulder prosthesis of FIG. **6a** illustrating an applied load force. An implantable shoulder prosthesis **100** can comprise a glenoid joint member **103**, a dampener **104** and a glenoid fixation member **106**. In this embodiment, the glenoid fixation member **106** is a fin; however, other types glenoid fixation members **106** may be used to attach the glenoid member **101** to a scapula **110**.

The glenoid joint member **103** can comprise a hinge arm **600** that is connected to the glenoid fixation member **106** at hinged pin joint **602**. In this embodiment, the dampener **104** is positioned between the glenoid joint member **103** and the glenoid fixation member **106** so as to absorb and dissipate an applied load force **116**. For example, referring to FIG. **6b**, when a load force is applied off-center to a glenoid joint surface **102** of the glenoid joint member **103**, a portion of the dampener **104** absorbs the applied load force **116**, allowing the glenoid joint member **103** to articulate with respect to the hinged pin joint **602**. As a result, a reduced load force is transferred from the glenoid joint member **103** to the glenoid fixation member **106**.

FIG. **7** is a top perspective view (a view in an inferior direction from a location superior to the patient's shoulder joint) of an implantable shoulder prosthesis comprising a dampening system in accordance with embodiments of the present invention. An implantable shoulder prosthesis **100** can comprise a glenoid member **101** and a dampening system **701**.

The dampening system **701** may comprise at least one piston **702** connected to a hydraulic or pneumatic assembly **704**, which is positioned between a medial face **122** of the glenoid member **101** and a scapula **110**. The dampening sys-

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tem **701** is constructed and arranged to absorb and dissipate a load force **116**, such as to the load force shown in FIG. **6b**, applied to a glenoid joint surface **102** of the glenoid member **101**.

In this embodiment, the dampening system **701** is surrounded by a protective membrane **700**. The protective membrane **700** can comprise a compressible material, for example, a rubber compound, plastic compound, a foam material, a silicon material and the like. In some embodiments, the protective membrane **700** is further constructed and arranged to absorb and dissipate a load force **116** that is applied to the glenoid joint surface **102** of the glenoid member **101**. In an alternative embodiment, a fluid filled reservoir can be used as a shock absorbing assembly. In another alternative embodiment, a spring can be used as a shock absorbing assembly, such as a spring selected from the group consisting of: torsional, compression, constant force, and/or Belleville springs.

FIG. **8** is an anterior facing environmental view of an implantable shoulder prosthesis comprising a dampener in accordance with embodiments of the present invention. A shoulder prosthesis **100** can further comprise a glenoid member **101** having at least one stabilizing member **800** extending from the glenoid member **101** in a medial direction MD. In another embodiment, the stabilizing member **800** extends from the glenoid member **101** in a direction that is transverse to the medial face **122** of the glenoid member **101**.

The stabilizing member **800** can comprise at least one attachment orifice constructed and arranged to receive an attachment mechanism **804**, such as, a screw, bolt and washer, or molly bolt. For example, the attachment mechanism **804** can pass through the attachment orifice and into a scapula **110**. When engaged, the attachment mechanism **804** operates to secure the stabilizing member **800** to a lateral surface of a scapula **110**. In one embodiment, the lateral surface is an anterior surface of a scapula **110**. Alternatively or additionally, the lateral surface is a posterior surface of a scapula **110**.

In another embodiment, the stabilizing member **800** can further comprise a Dacron or other biocompatible mesh material **806** for attaching rotator cuff muscles and tendons thereto. In another embodiment, the stabilizing member **800** can further comprise a suture clasp **802** or a plurality thereof for attaching rotator cuff muscles and tendons thereto.

FIGS. **9a** and **9b** are 3-dimensional views of an implantable shoulder prosthesis in accordance with embodiments of the present invention. A shoulder prosthesis **100** can further comprise a glenoid member **101** and at least one stabilizing member **800** attached thereto. In this embodiment, the stabilizing member **800** is attached to a central region of the medial face of the glenoid member **101**. A dampener, **104**, may be positioned between glenoid member **101** and stabilizing member **800** such as to absorb shock and/or allow flexing of glenoid member **101** relative to stabilizing member **800**.

The stabilizing member **800** can comprise an elongated arm having at least one attachment orifice, such as at least one of attachment orifice **812a** or **812b** positioned thereon, which is constructed and arranged to receive an attachment mechanism, such as a screw, bolt, rivet or other element for passing through attachment orifice **812a** or **812b** and into scapula **110**. When engaged, the attachment mechanism operates to secure the stabilizing member **800** to a lateral surface of a scapula **110**. In one embodiment, the elongated arm of the stabilizing member **800** comprises both first and second attachment orifices **812a** and **812b**, which are spaced apart from each other as shown.

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In one embodiment, attachment orifices **812a** or **812b** comprises a non-threaded screw hole. In another embodiment, attachment orifices **812a** or **812b** comprises a threaded screw hole.

The elongated arm of the stabilizing member **800** can further comprise a first arm portion **808** and a second arm portion **810**. In one embodiment, a first attachment orifice **812a** is positioned along the first arm portion **808** and a second attachment orifice **812b** is positioned along the second arm portion **810**. In this embodiment, a planar surface of the first arm portion **808** can be offset from a planar surface of the second arm portion **810**.

The implantable shoulder prosthesis **100** can further comprise an adhesive material that secures the stabilizing member **800** to a lateral surface of a scapula **110**. The implantable shoulder prosthesis **100** can further comprise an adhesive material that secures the glenoid member **101** to a glenoid cavity of a scapula **110**. The adhesive material can comprise a glue material, a cement material, a bone bonding material or a combination thereof.

In one embodiment, the glenoid joint surface **102** of the glenoid member **101** is concave, such that, the glenoid joint surface **102** is constructed and arranged to interface with a convex humeral head portion of a humeral member. In another embodiment, the glenoid joint surface **102** of the glenoid member **101** comprises a concave cross section relative to a superior-inferior direction of extension. In another embodiment, the glenoid joint surface **102** of the glenoid member **101** comprises a concave cross section relative to an anterior-posterior direction of extension. In another embodiment, the glenoid joint surface **102** of the glenoid member **101** comprises a concave cross section relative to a superior-inferior direction of extension and an anterior-posterior direction of extension.

The stabilizing member **800** and the glenoid member **101** can each comprise a material such as cobalt-chrome, titanium, stainless steel, tantalum, polyethylene, silicon, nylon, polyester polymers or a combination thereof. In one embodiment, the glenoid member **101** comprises a different material than the stabilizing member **800**, and in another embodiment, the glenoid member **101** and the stabilizing member **800** comprise the same material. In another embodiment, the glenoid member **101** and the stabilizing member **800** each comprise a material having a different stiffness. Further, the stabilizing member **800** can comprise a malleable material.

The stabilizing member **800** and the glenoid member **101** can further comprise a laminated material. The laminated material can comprise at least two materials, such as cobalt-chrome, titanium, stainless steel, tantalum, polyethylene, silicon, nylon and polyester polymers.

In another embodiment, the glenoid member **101** can comprise autologous bone harvested from intra-oral sources of a human patient. For example, the autologous bone can be harvested from an iliac crest of a pelvis.

In another embodiment, the glenoid member **101** can comprise allograft bone harvested from intra-oral sources of a different human patient. For example, the allograft bone can be harvested from an iliac crest of a pelvis.

In another embodiment, the glenoid member **101** can comprise xenograft bone harvested from intra-oral sources of a bovine species or a porcine species.

In addition, the stabilizing member **800** can be constructed and arranged to conform to an anterior or posterior surface of a scapula **110**. In one embodiment, the stabilizing member **800** is machined to conform to the contour of a patient's scapula **110**. The stabilizing member **800** can be machined

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according to an X-ray image, CT scan, MRI, Nuclear image, Ultra sound image or combinations thereof.

In an alternative embodiment, one or more extending members, protrude from first arm portion **808** and/or second arm portion **810**, such as at the locations of attachment orifices **812a** and **812b** respectively. These protrusions may be configured to attach to scapula **110** and/or protrude into scapula **110**.

FIGS. **10a** and **10b** are top perspective views of an implantable shoulder prosthesis in accordance with embodiments of the present invention. A shoulder prosthesis **100** can further comprise a glenoid member **101** and first and second stabilizing members **906**, **908** attached thereto. In one embodiment, the first and second stabilizing members **906**, **908** are attached to an off-center region of the medial face **122** of the glenoid member **101**. In another embodiment, the first and second stabilizing members **906**, **908** are attached to the medial face **122** of the glenoid member **101** such that a side surface of each of the first and second stabilizing members **906**, **908** is aligned with an outer side surface of the glenoid member **101**. Further, embodiments can comprise first and second stabilizing members **906**, **908** that can be removably attached to the glenoid member **101**.

The first and second stabilizing members **906**, **908** can comprise a material such as cobalt-chrome, titanium, stainless steel, tantalum, polyethylene, silicon, nylon, polyester polymers, other biocompatible materials, or a combination thereof.

The first and second stabilizing members **906**, **908** can further comprise at least one attachment orifice positioned thereon, which is constructed and arranged to receive attachment mechanisms **910a** and **910b**. When engaged, the attachment mechanisms **910a** and **910b** operate to secure the first and second stabilizing members **906**, **908** to lateral surfaces of a scapula **110**.

The attachment mechanisms **910a** and **910b** can comprise a bone screw, a molly bolt, a machine screw, a rivet or a bolt. The attachment mechanisms **910a** and **910b** can be further secured by nuts **912a** and **912b**.

In addition, the attachment mechanisms **910a** and **910b** and nuts **912a** and **912b** can comprise a material such as cobalt-chrome, titanium, stainless steel, tantalum, polyethylene, silicone, nylon, polyester polymers, other biocompatible materials, or a combination thereof.

FIG. **11** is top perspective view of an implantable shoulder prosthesis comprising a hinge in accordance with embodiments of the present invention. Shoulder prosthesis **100** can further comprise a glenoid member **101** having a hinge **904**, which allows a head portion of a humeral member to dislocate prior to stressing the glenoid member **101** of the implantable shoulder prosthesis **100**. The hinge **904** can comprise a material such as rubber, plastic, silicon and the like.

FIGS. **12a**, **12b** and **12c** illustrate a plurality of hinge configurations of the glenoid joint surface of the implantable shoulder prosthesis of FIG. **11** in accordance with embodiments of the present invention.

Referring to FIG. **12a**, the glenoid member **101** can comprise a first-fourth portions connected together via a hinge **904**. In this embodiment, the hinge **904** comprises a first hinge portion, **904a**, that extends in a superior/inferior direction and a second hinge portion **904b** that extends in an anterior/posterior direction.

In one embodiment, a torsional stiffness of the first hinge portion is greater than a torsional stiffness of the second hinge portion. In another embodiment, a torsional stiffness of the first hinge portion is less than or equal to a torsional stiffness of the second hinge portion.

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Referring to FIG. **12b**, the glenoid member **101** can comprise first and second portions connected together via hinge **904b**. In this embodiment, the hinge **904b** extends in an anterior/posterior direction, allowing the first and second portions of the glenoid member to flex about a longitudinal axis of the hinge **904b**.

Referring to FIG. **12c**, the glenoid member **101** can comprise first and second portions connected together via a hinge **904a**. In this embodiment, the hinge **904a** extends in an superior/inferior direction, allowing the first and second portions of the glenoid member to flex about a longitudinal axis of the hinge **904a**.

FIGS. **13a** and **13b** are top perspective views of an implantable shoulder prosthesis in accordance with embodiments of the present invention. A shoulder prosthesis **100** can further comprise a glenoid member **101** and a stabilizing member **800**, **906** having a dampener **104**. In this embodiment, the dampener **104** positioned along the stabilizing member **800**, **906**, and is constructed and arranged to absorb a load force **116** applied to the glenoid joint surface **102** of the glenoid member **101** such that a reduced load force is transferred to the attachment mechanisms **910a** and **910b** and/or the glenoid cavity of a scapula **110**. As a result of the dampening of the load force **116**, notching and chipping of bone and component loosening associated with the implantable shoulder prosthesis **100** is reduced.

FIG. **14** is a top perspective view of an implantable shoulder prosthesis in accordance with embodiments of the present invention. A shoulder prosthesis **100** can further comprise a glenoid member **101**, at least one glenoid fixation member **106** and at least one stabilizing member **906**, **908**. In this embodiment, the glenoid fixation member **106** can be constructed and arranged to attach the glenoid member **101** to a glenoid cavity of a scapula **110** and the attachment mechanisms **910a** and/or **910b** operate to secure the at least one stabilizing member **906**, **908** to a lateral surface of a scapula **110**. Glenoid fixation members **106** may comprise pins, screws, fins, keels or other scapular engagement elements.

FIG. **15** is a top perspective view of an implantable shoulder prosthesis in accordance with embodiments of the present invention. A shoulder prosthesis **100** can further comprise a glenoid member **101**, a dampener **104** and first and second stabilizing members **906**, **908**.

FIG. **16** is an anterior facing environmental view of an implantable shoulder prosthesis in accordance with embodiments of the present invention. A shoulder prosthesis **100** can further comprise a glenoid member **402** with a convex geometry, an optional dampener **104** and a stabilizing member **800** having an enlarged surface **800a**. The enlarged surface **800a** of the stabilizing member **800** can distribute applied forces such as to prevent the fracture of a scapula bone **110**.

Glenoid member **402** can comprise a material such as cobalt-chrome, titanium, stainless steel, tantalum, polyethylene, silicon, nylon, polyester polymers or a combination thereof. In another embodiment, glenoid member **402** can comprise a dampening portion and/or material.

The shoulder prosthesis **100** can further comprise a cushion material **1000** connected to the stabilizing member **800**, and positioned between the stabilizing member **800** and a surface of a scapula **110**. The cushion material **1000** can comprise a material such as foam, rubber, plastic, silicon and the like.

FIG. **17** is an anterior facing environmental view of a constrained implantable shoulder prosthesis comprising a dampener in accordance with embodiments of the present invention. A shoulder prosthesis **100** can further comprise a glenoid member **101**, an optional dampener **104** and a stabi-

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lizing member **800** having an enlarged surface **800a**. The enlarged surface **800a** of the stabilizing member **800** can distribute applied forces such as to prevent the fracture of a scapula bone **110**.

Glenoid member **101** can comprise a material such as cobalt-chrome, titanium, stainless steel, tantalum, polyethylene, silicon, nylon, polyester polymers or a combination thereof. In another embodiment, glenoid member **101** can comprise a dampening portion and/or material.

Glenoid member **101** is fixedly attached to a first end **3000a** of universal joint **3000**. Universal joint **3000** is fixedly attached at a second end **3000b** to prosthetic humeral head and stem **3001**.

The shoulder prosthesis **100** can further comprise a cushion material **1000** connected to the stabilizing member **800**, and positioned between the stabilizing member **800** and a surface of a scapula **110**. The cushion material **1000** can comprise a material such as foam, rubber, plastic, silicon and the like.

FIG. **18** is a top perspective view of an implantable shoulder prosthesis in accordance with embodiments of the present invention. A shoulder prosthesis **100** can further comprise a glenoid member **101**, a dampener **104** and a continuous scapular fixation member **950**.

In this embodiment, the dampener **104** is positioned between the glenoid member **101** and the scapular fixation member **950**. Dampener **104** may comprise a foam or other cellular material with a rigidity constructed and arranged to allow glenoid member **101** to deflect under high loads, such as to prevent dislocation of a natural or artificial humeral head, and or prevent damage to scapula **110**. The scapular fixation member **950** is constructed and arranged to conform to surfaces of a scapula **110**. Such surfaces can include an anterior surface, a posterior surface and a glenoid surface of a scapula **110**.

FIG. **19** is a top perspective view of an implantable shoulder prosthesis and surgical tools for implanting the shoulder prosthesis in accordance with embodiments of the present invention. A shoulder prosthesis **100** can further comprise a glenoid assembly **951** comprising a glenoid member **101**, a scapular fixation member **950** and a cushion material **1000**.

The cushion material **1000** is positioned between the scapula fixation member **950** and surfaces of a scapula **110**, such that the shoulder prosthesis **100** conforms to the contour of the scapula **110**.

Also shown in FIG. **19** is tool **2500** comprising handle **2501**, ratchet assembly **2502** and engaging tip **2503**. Tool **2500** is constructed and arranged such that rotation of handle **2501** causes ratchet assembly **2502** and tip **2503** to rotate. Tip **2503**, such as a Phillips, torx, hex or other fastener engaging tip is configured to engage the head of attachment mechanism **910a** and/or **910b**.

Also shown in FIG. **19** is tool **2600** comprising handle **2601**, shaft **2602** and wrench end **2603**. In a preferred embodiment, shaft **2602** is malleable such as to be shaped by a clinician during a surgical implantation procedure. Wrench end **2603** is configured to engage nut **912a** and/or **912b** such that rotation of attachment mechanism **910a** and/or **910b**, respectively, prevents rotation of nut **912a** and/or **912b**. In an alternative embodiment, wrench end **2603** may be constructed and arranged to rotate, such as via rotation of handle **2601**. In another alternative embodiment, tool **2500** and/or tool **2600** may include torque or other force measurement feedback such as to tighten attachment mechanisms **910a** and/or **910b** to nuts **912a** and/or **912b**, respectively, at a desired level of compression.

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FIG. **20** is a top perspective view of a constrained implantable shoulder prosthesis in accordance with embodiments of the present invention. A shoulder prosthesis **100** can further comprise a constrained humeral cup **1308** that is constructed and arranged to interface with an convex glenoid portion **1306**.

Glenoid portion **1306** is attached to a scapular fixation member **950** by a screw **1302** and a flexible membrane **1304**. The flexible membrane **1304** can comprise a compressible material, for example, a rubber compound, plastic compound, a foam material, a silicon material and the like, and is constructed and arranged to absorb and dissipate a load force **116** that is applied to the artificial humeral head **1306**. In addition, the screw **1302** can comprise a spring **1300** to further absorb and dissipate a load force **116** that is applied to the artificial humeral head **1306**.

The constrained humeral cup **1308** is constructed and arranged to limit movement of a humeral member. For example, the humeral cup **1308** can limit movement of humeral member in at least two directions. In one embodiment, humeral cup **1308** surrounds greater than 180 degrees of the glenoid portion **1306**. In an alternative embodiment, one or both ends of cup **1308** are constructed of bioabsorbable material such that the constraint is time limited. Duration of constraint may be selected to allow healing or other physiologic processes to occur prior to full motion enabling of the patient's shoulder joint. Typical duration times include periods greater than one week, greater than one month, greater than 3 months and greater than 6 months.

FIG. **21** is a top perspective view of an implantable shoulder prosthesis in accordance with embodiments of the present invention. A shoulder prosthesis **100** can further comprise a concave humeral cup **1402** that is constructed and arranged to interface with an convex glenoid portion **1400**. In this embodiment, glenoid portion **1400** is integral with the scapular fixation member **950**.

FIGS. **22a** and **22b** are cross-sectional views of a glenoid member **101** having expandable glenoid fixation members in accordance with embodiments of the present invention. A shoulder prosthesis **100** can further comprise a glenoid member **101** having a plurality of glenoid fixation members **106** that are expandable.

An expandable glenoid fixation member **106** comprises an outer screw portion **1500** and an inner expanding post **1502**. The outer screw portion **1500** comprises threads **1501** for penetrating human bone, such as, a scapula **110**. The inner screw portion **1502** comprises threads **1503**, such that rotational movement of the inner screw portion **1502** operates to advance or retract the inner screw portion **1502** within the outer screw portion **1500**.

Referring to FIG. **22b**, the advancement of the inner screw portion **1502** within the outer screw portion **1500** controls the expansion of the outer screw portion **1500**. For example, when the inner screw portion **1502** is advanced within the outer screw portion **1500**, an expanded portion **1504** of the outer screw portion **1500** is formed.

In this embodiment, the expansion of the outer screw portion **1500**, as shown in the middle fixation member **106**, can tighten a glenoid fixation member **106** that has become loose and/or prevent initial loosening.

FIGS. **23a**, **23b**, **23c** and **23d** are cross-sectional views of a glenoid member having expandable glenoid fixation members in accordance with embodiments of the present invention. A shoulder prosthesis can further comprise a glenoid member **101** and an expandable glenoid fixation member **106**.

Referring to FIG. **23b**, an expandable glenoid fixation member **106** can comprise a fin-type member **1602** having an

expandable portion **1603**. A balloon tool **1604** can be used to expand the fin-type member **1602**, such as by expansion of a balloon portion with a fluid. Alternatively or additionally, tool **1604** may comprise an expandable cage, such as a nitinol cage expanded with heat, or an assembly that expands due to applied magnetic forces.

Referring to FIG. **23c**, an expandable glenoid fixation member **106** can comprise a fin-type member **1605** having a Nitinol coil **1606** positioned within an expandable portion **1603**. A heated tip **1607** of a heating tool **1608** can be used to expand the Nitinol coil **1606** which in turn expands portion **1603**.

Referring to FIG. **23d**, an expandable glenoid fixation member **106** can comprise a fin-type member **1609** having a sharp pin **1610**. A tool **1611**, such as a rigid shaft, can be used to extend the sharp pin **1610** outwardly from the fin-type member **1609**.

FIG. **24** is a top perspective view of an implantable shoulder prosthesis comprising a plurality of glenoid fixation members each having an access port through which material such as an adhesive material can be added in accordance with embodiments of the present invention. A shoulder prosthesis **100** can comprise a glenoid member **101** and a plurality of glenoid fixation members **106** each having an access port or adhesive inlet through which an adhesive material can be added. The access port or adhesive inlet of the glenoid fixation members **106** can comprise a resealable septum **1706**, which can be connected inline with a chamber **1708** and a transport tube **1712**.

After implantation of the shoulder prosthesis **100**, a cavity **1716** can form in the glenoid region of a scapula **110** as a result of various types of load forces exerted on glenoid member **101**. As a result of one or more cavities **1716**, notching and chipping of scapula bone and/or loosening of the glenoid member **101** may occur. To prevent further damage to or loosening of the shoulder prosthesis **100** and surrounding glenoid area of the scapula **110**, a fill material **1702** can be injected, via a syringe **1700** into the cavity **1716** formed in the scapula **110**. Fill material **1702** may comprise a cement such as orthopedic bone cement, a glue material, an elastomeric material, a gel foam, a suture material, a nitinol filament, and/or other biocompatible, injectable material. In one embodiment, a needle **1704** of the syringe **1700** is used to pierce the resealable septum **1706**. Once pierced, the adhesive material **1702** can be injected into the chamber **1708**, through a transport tube **1712** of the glenoid fixation member **106**, and out of an output port **1714** into the cavity **1716**. As a result, the notching and chipping of scapula bone and/or loosening of the glenoid member **101** can be prevented.

In one embodiment, the resealable septum **1706** is constructed and arranged to be accessed percutaneously. In another embodiment, the resealable septum **1706** is constructed and arranged to be accessed in a minimally invasive procedure. In another embodiment, the resealable septum **1706** is constructed and arranged to be accessed in an open surgical procedure.

Glenoid fixation members **106** may comprise a rotatable anchor **107** configured to engage the scapula **110** when fixation member **106** is rotated; however, other types glenoid fixation members **106** may be used to attach the glenoid member **101** to a scapula **110**. For example, a screw, pin, keel or other projection may include an access port or adhesive inlet through which an adhesive or other fill material can be injected.

FIGS. **25a**, **25b** and **25c** are top perspective views of an implantable shoulder prosthesis comprising a plurality of glenoid fixation members in which subsets of the plurality of

glenoid fixation members are engaged during separate procedures in accordance with embodiments of the present invention. A shoulder prosthesis **100** can comprise a glenoid member **101** and a plurality of glenoid fixation members **106**. For example, the shoulder prosthesis can comprise a first glenoid fixation member **106a**, a second glenoid fixation member **106b**, and third glenoid fixation member **106c**, and a fourth glenoid fixation member **106d**. In this embodiment, the glenoid fixation members **106** (e.g., first-fourth glenoid fixation members **106a/106b/106c/106d**) comprise rotatable engagement anchors; however, other glenoid types of glenoid fixation members **106** can be used to attach the glenoid member **101** to a scapula **110**.

In one embodiment, the rotatable engagement anchors can comprise engageable (e.g. comprising a slot for rotation with a screwdriver) securing portions **109** for attaching the glenoid member **101** to a glenoid cavity of a scapula **110**. Further, the engageable securing portions can be engaged in response to a magnetic field.

Referring to FIG. **25a**, the glenoid member **101** is shown having a complete set of glenoid fixation members **106a/106b/106c/106d** implanted in a scapula **110**. In this embodiment, the complete set glenoid fixation members **106a/106b/106c/106d** are shown un-engaged.

Referring to FIG. **25b**, a first subset of glenoid fixation members **106b** and **106c** are shown engaged, securing the glenoid member **101** to a glenoid cavity of a scapula **110**.

Referring to FIG. **25c**, the remaining glenoid fixation members **106a** and **106d** are shown engaged, further securing the glenoid member **101** to a glenoid cavity of a scapula **110**. The complete set of engaged glenoid fixation members **106a/106b/106c/106d** is shown.

In one embodiment, the first subset of glenoid fixation members **106b** and **106c** or a portion thereof is engaged, securing the glenoid member **101** to a glenoid cavity of a scapula **110** via securing portion **109** in a first operation or procedure. Subsequently, if the glenoid member **101** becomes loose subsequent to the first operation or procedure, the remaining glenoid fixation members **106a** and **106d** or a portion thereof, can be engaged via securing portion **109**, thus re-securing the glenoid member **101** to a glenoid cavity of a scapula **110**. For example, in a second operation or procedure, at least 24 hours after the engagement of the first subset of glenoid fixation members **106b** and **106c** or a portion thereof, the remaining glenoid fixation members **106a** and **106d** or a portion thereof is engaged.

In one embodiment, the remaining glenoid fixation members **106a** and **106d** or a portion thereof can be accessed and engaged percutaneously. In another embodiment, the remaining glenoid fixation members **106a** and **106d** or a portion thereof can be accessed and engaged in a minimally invasive procedure. In another embodiment, the remaining glenoid fixation members **106a** and **106d** or a portion thereof can be accessed and engaged in an open surgical procedure.

FIG. **26** is a block diagram of a pressure sensing system in accordance with embodiments of the present invention. A pressure sensing system **2001** can comprise signal processor **2000**, such as, a microprocessor, a digital signal processor, and the like, at least one pressure sensor **2002**, an optional biasing element (such as biasing element **2004** of FIG. **28**), a communication device **2006** and a power supply **2008**.

In some embodiments, the signal processor **2000** comprises data storage elements, such as, non-volatile and volatile memory. In addition, in other embodiments, the pressure sensing system **2001** can further comprises external data storage elements (not shown), such as, non-volatile and volatile memory, which are connected to the signal processor **2000**.

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The pressure sensor **2002**, or a plurality thereof, are electrically connected to the signal processor **2000**. The signal processor **2000** receives pressure information in the form of analog or digital signals from the pressure sensor **2002**, and as a result, determines if the measured pressure is above, below or equal to a predetermined threshold value stored in system memory.

The power supply **2008** is electrically connected to the pressure sensing system **2001**, and supplies electrical energy thereto. In one embodiment, the power supply **2008** comprises one or more rechargeable batteries of the following types or a combination thereof: Lead-acid, Alkaline, Ni-iron, Ni-cadmium, NiH₂, NiMH, Ni-zinc, Li ion, Li polymer, Li sulfur[8], Li titanate, Thin film Li, ZnBr, or Silver zinc. In other embodiments, the power supply comprises one or more single-use type batteries.

The communication device **2006** is electrically connected to the signal processor **2000**. The communication device **2006** can be used to program, initialize, reset, or adjust the pressure sensing system **2001**. In one operating mode, the communication device **2006** receives program data and initialization data from an external device.

In another operating mode, the communication device **2006** transmits stored pressure information (e.g., data). For example, the communication device can be configured to generate a pressure sensor signal corresponding to a pressure measured between the medial face **122** of the glenoid member **101** and a glenoid cavity of a scapula **110**. Sensing system **2001** may comprise wireless telemetry, such as information transferred via electromagnetic waves such as radiofrequency waves, light such as infrared light, or other wireless means which transmit information to an external receiver, such as a computer, cellular telephone or the like.

The communication device **2006** can comprise a wireless communication device for transmitting the pressure information or pressure sensor signal. The wireless communication device can operate on a frequency band selected from the group consisting of: 30-300 kHz, 300-3000 kHz, 3-30 MHz, 30-300 MHz, 300-3000 MHz, 3-30 GHz and 30-300 GHz.

FIG. **28** is a top perspective view of an implantable shoulder prosthesis comprising a pressure sensing system in accordance with embodiments of the present invention. An implantable shoulder prosthesis **100** can comprise a glenoid member **101** and pressure sensing system **2001**.

In one embodiment, the signal processor **2000**, the communication device **2006** and the power supply **2008** are encapsulated within the glenoid member **101**. In other embodiments, the signal processor **2000**, the communication device **2006** and the power supply **2008** of the pressure sensing system **2001** are partially formed in the glenoid member **101**.

The pressure sensing system **2001** optionally comprises biasing elements **2004a** and **2004b** that bias the pressure sensors **2002a** and **2002b** in an outward direction, away from the medial face **122** of the glenoid member **101**. The biasing element **2004** can comprise a spring, a rubber plug, a foam plug, a silicon plug, a plastic plug or a combination thereof.

In the case of a deformed scapula **110**, a bulker **2012** can be secured to a deformed portion of a scapula **110** by a fill material, such that an implantable prosthesis **100** can be securely attached to the scapula, such as to prevent rocking.

In one embodiment, fill material **1702** is selected from the group consisting of: glue or other adhesive material; cement such as orthopedic bone cement, gel foam, fill material including one or more bone grafts, elastomeric material; and combinations of these.

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The methods disclosed herein can be implemented by the pressure sensing systems **2001** of FIGS. **26** and **28**, or equivalent systems, executing a unique set of instructions stored in system memory. As will be appreciated by those skilled in the art, a unique set of instructions can be implemented or embodied in software, firmware, or a combination thereof.

FIG. **27** is a flow diagram illustrating a method of operating a pressure sensing system in accordance with embodiments of the present invention. A pressure sensing system, such as the pressure sensor system **2001** of FIG. **26** or **28**, is powered on and initialized to execute a unique set of instructions. In one embodiment, the unique set of instructions correspond to the method of operation disclosed in FIG. **27**.

The signal processor **2000** of the pressure sensing system **2001** receives pressure information in the form of analog or digital signals from the pressure sensor **2002** (**10**). The signal processor **2002** converts/processes the received signal to digital form if necessary (**20**), and determines if the measured pressure is above, below or equal to a predetermined threshold value stored in system memory (**30**). If the measured pressure is above the predetermined threshold, the pressure sensing system continues to receive and process pressure information from the pressure sensor **2002** (**10/20**). If the measured pressure is equal to or below the predetermined threshold, a modification signal is generated by the signal processor **2000** indicating that the glenoid member **101** may be loose.

Furthermore, the pressure sensing system **2001** may store the received pressure information received from the pressure sensor **2002** for each iteration in system memory. This stored information, can be later accessed via the communication device **2006**.

FIG. **29** is a lateral/medial facing view of a scapula illustrating pressure sensor locations in accordance with embodiments of the present invention. The implantable shoulder prosthesis **100** comprising the pressure sensing system **2001** as illustrated in FIG. **26** can be constructed and arranged so that one or more pressure sensors **2002** monitor the pressure at least one of four glenoid cavity locations, which correspond to an upper glenoid cavity location **2100**, a right glenoid cavity location **2102**, and lower glenoid cavity location **2104** and a left glenoid cavity location **2106**.

FIG. **30** is a top perspective view of an implantable shoulder prosthesis comprising a plurality of access ports through which an adhesive material can be added in accordance with embodiments of the present invention. A shoulder prosthesis **100** can comprise a glenoid member **101** having at least one access port or adhesive inlet disposed therein through which an adhesive material can be added.

The access port or adhesive inlet of the glenoid member **101** can comprise a resealable septum **1706**, which can be connected inline with a chamber **1708** and an outlet port **1714**.

After implantation of the glenoid member **101**, a notch **2200a** and/or **2200b** can form in the glenoid region of a scapula **110** as a result of various types of load forces exerted on glenoid member **101**. As a result of the notch **2200a** and/or **2200b**, loosening of the glenoid member **101** may occur, such as due to rocking. To prevent further damage to or loosening of the shoulder prosthesis **100** and surrounding glenoid area of the scapula **110**, an adhesive or other fill material **1702**, such as orthopedic bone cement or other fill material described above, can be injected via a syringe **1700** into notch **2200a** and/or **2200b** formed in the scapula **110**.

In one embodiment, a needle **1704** of the syringe **1700** is used to pierce the resealable septum **1706**. Once pierced, the adhesive material **1702** can be injected into the chamber **1708**

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and out of an output port **1714** into the notch **2200a** and/or **2200b**. As a result, loosening of the glenoid member **101** can be prevented.

One or more of the components described hereabove may be bioabsorbable or comprise a bioabsorbable portion, as has been described in reference to FIG. **20** hereabove. Bioabsorption of these portions is typically chosen to be at least one week, at least one month, at least three months, and at least six months. Single components or multiple components may be bioabsorbable, such as bioabsorbable portions which absorb at similar or dissimilar rates.

While the preferred embodiments of the devices and methods have been described in reference to the environment in which they were developed, they are merely illustrative of the principles of the inventions. Modification or combinations of the above-described assemblies, other embodiments, configurations, and methods for carrying out the invention, and variations of aspects of the invention that are obvious to those of skill in the art are intended to be within the scope of the claims.

We claim:

1. A method of securing an implantable shoulder prosthesis comprising:

initially securing at least one fixation member of a glenoid member to a scapula of a patient, the glenoid member including a penetrable, re-sealable septum; and delivering injectable material via the septum into at least one transport tube of the glenoid member, wherein the delivering of the injectable material is performed at least twenty four hours after the initial securing of the at least one fixation member.

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2. The method of claim **1** wherein the delivering of the injectable material causes the injectable material to exit at least one output port of the at least one fixation member.

3. The method of claim **1** wherein the glenoid member comprises an articulation surface and an opposing surface, and wherein the delivering of the injectable material causes the injectable material to exit at least one output port positioned on the opposing surface.

4. The method of claim **1** further comprising expanding the fixation member.

5. The method of claim **4** wherein the expanding of the fixation member is performed at least twenty four hours after the initial securing of the at least one fixation member.

6. A method of securing an implantable shoulder prosthesis comprising:

initially securing at least one fixation member of a glenoid member to a scapula of a patient, the glenoid member including a penetrable, re-sealable septum; and delivering injectable material via the septum into at least one transport tube of the glenoid member; and expanding the fixation member, wherein the expanding of the fixation member is performed at least twenty four hours after the initial securing of the at least one fixation member.

7. The method of claim **6** wherein the delivering of the injectable material causes the injectable material to exit at least one output port of the at least one fixation member.

8. The method of claim **6** wherein the glenoid member comprises an articulation surface and an opposing surface, and wherein the delivering of the injectable material causes the injectable material to exit at least one output port positioned on the opposing surface.

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